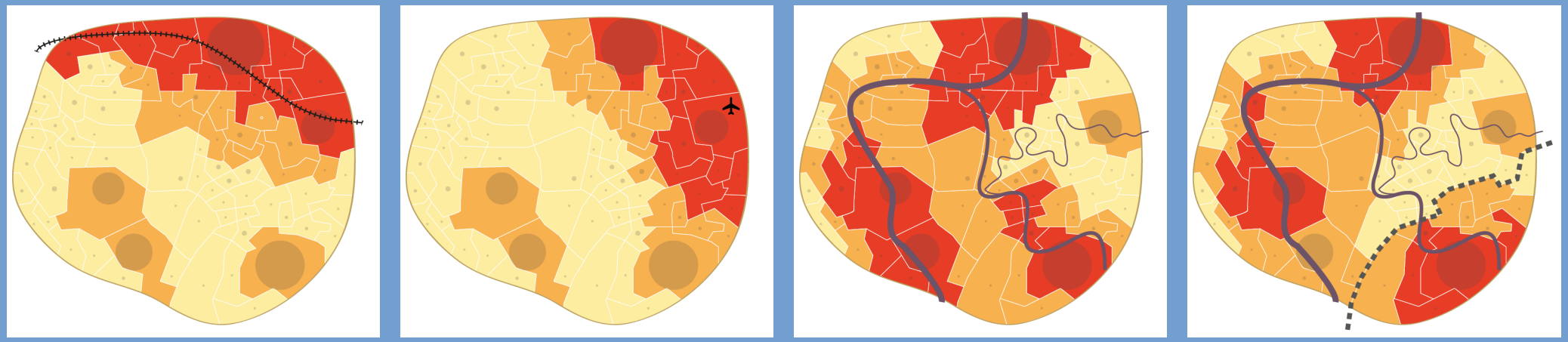
Enhancing Spatial Patterns Representations by Functional Semantic Simplification

An Interactive Tool for European Stakeholders



Timothée Giraud
Nicolas Lambert
Hadrien Commenges

ICC 2015

27th International Cartographic Conference. August 23-28, 2015 | Rio de Janeiro / Brazil

1

MAUP (Modifiable Area Unit Problem)

What is it?
Issues
How to solve it ?

2

Functional Indicators

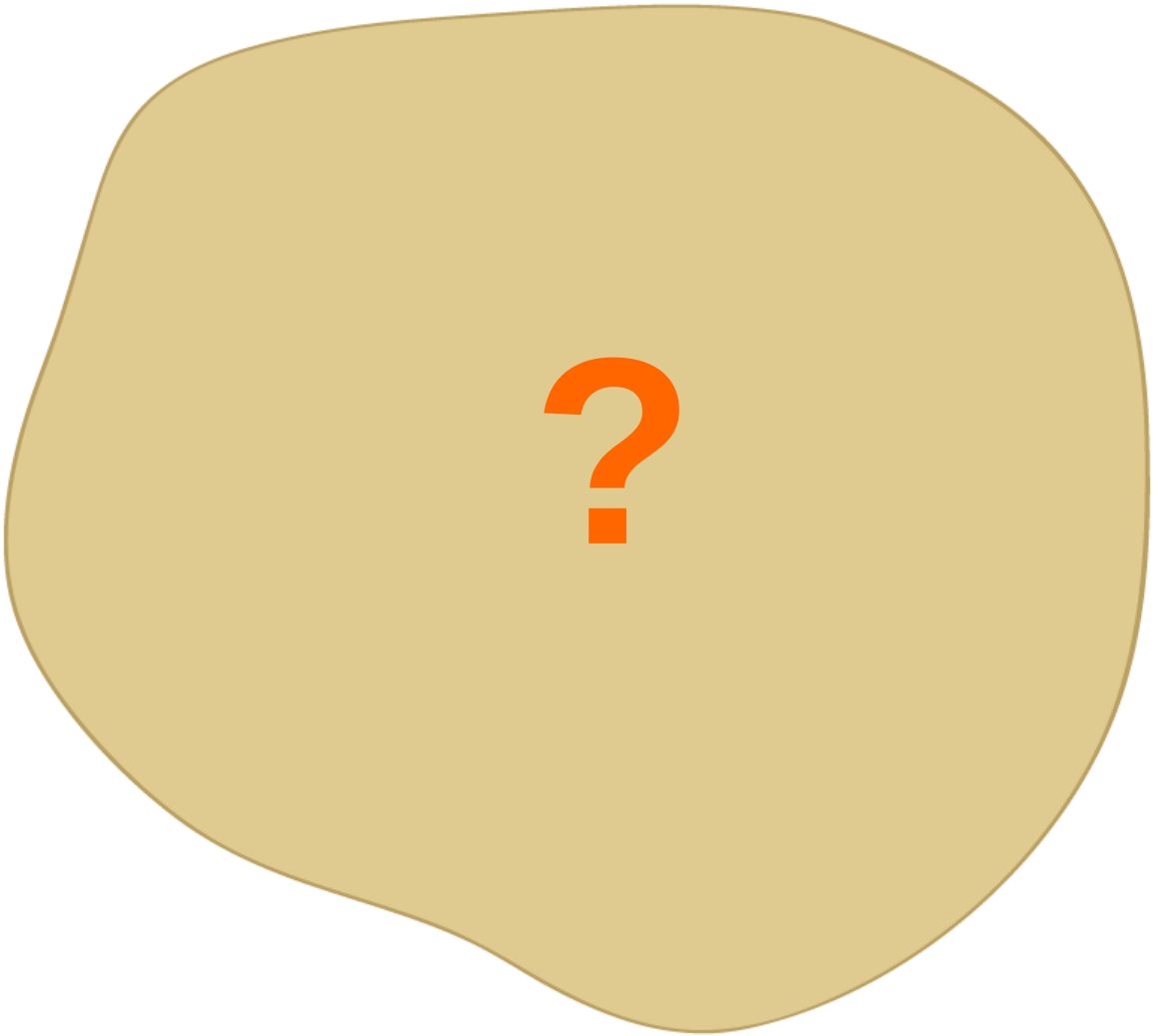
Spatial interaction modeling
Enhancing spatial paterns
Automatic computation

3

A European tool (FIT)

Features
Interest
Reproducibility

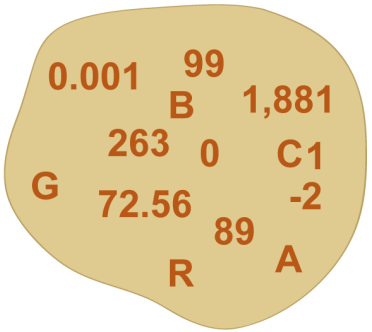
MAUP (Modifiable Area Unit Problem)



The reality is complex.

A map has to be simple.

MAUP (Modifiable Area Unit Problem)



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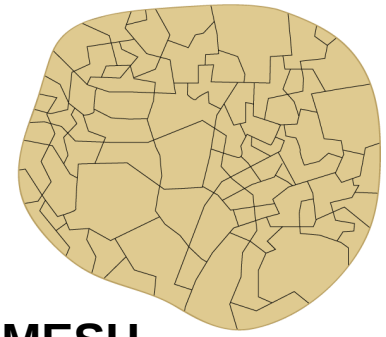

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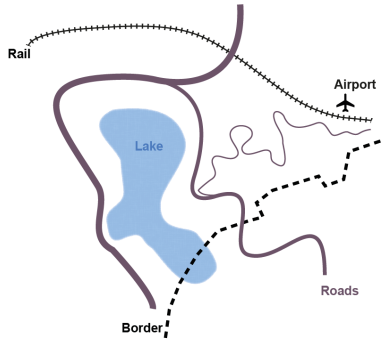
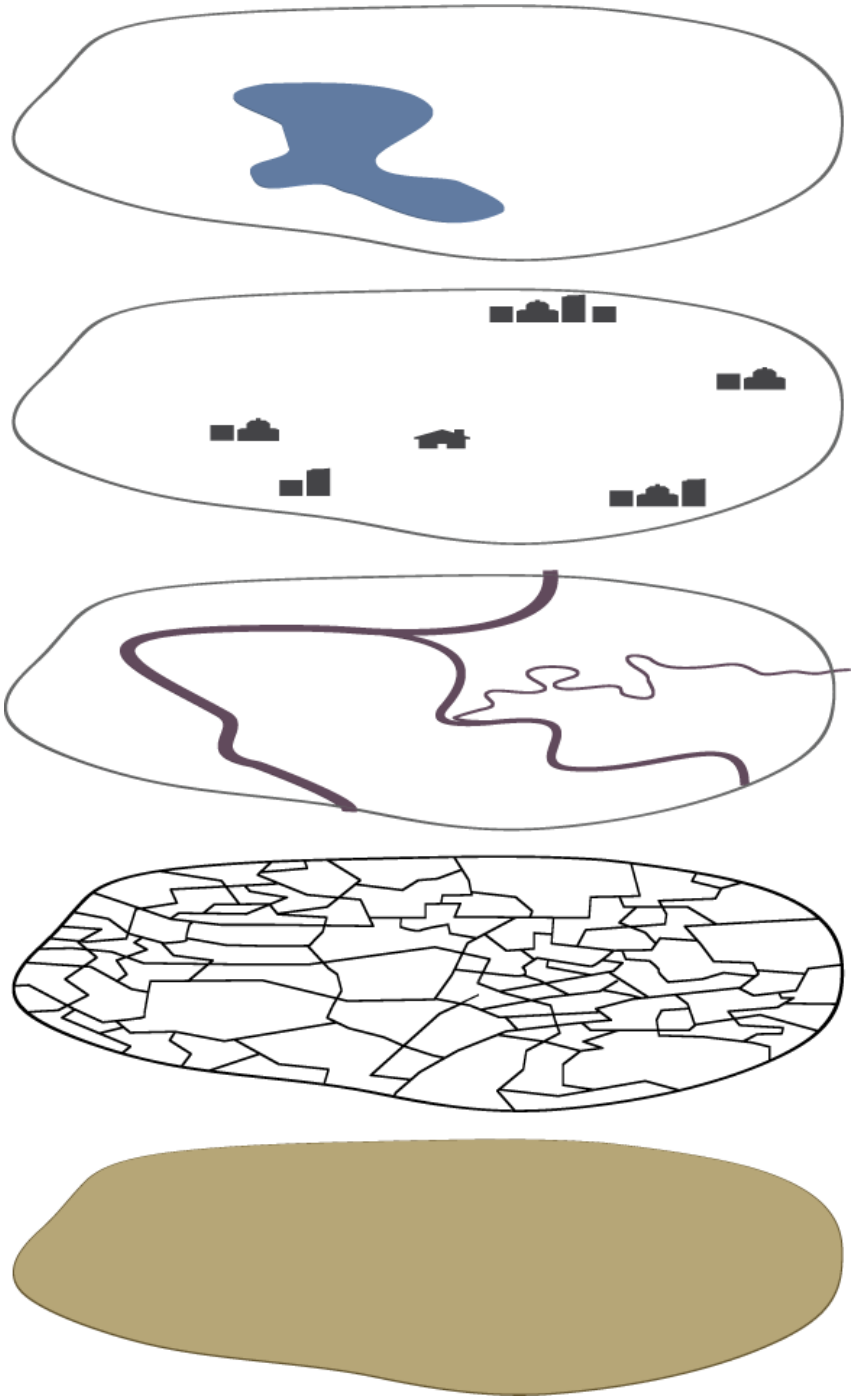
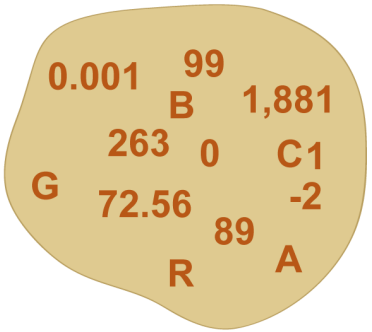


NATURAL AND ANTHROPIC FEATURES

MODELING REALITY



MAUP (Modifiable Area Unit Problem)



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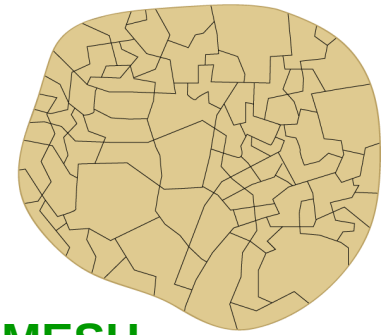

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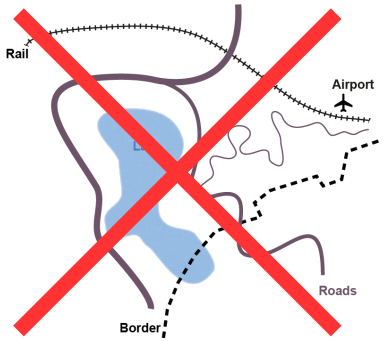
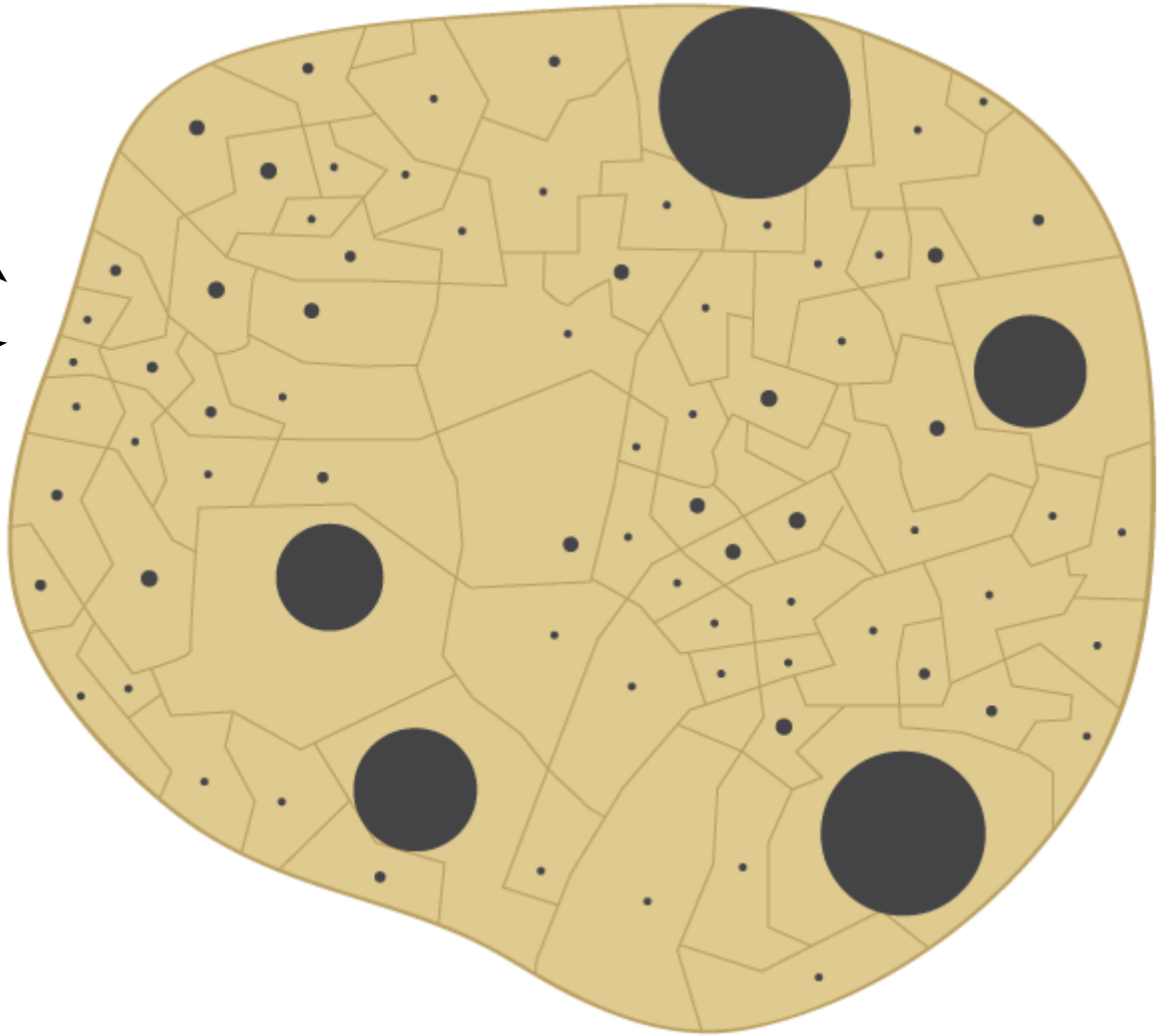
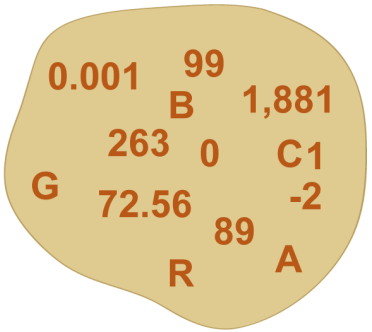


NATURAL AND ANTHROPIC FEATURES



Proportional Symbol Maps

MAUP (Modifiable Area Unit Problem)



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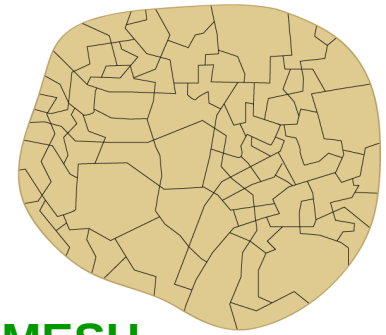

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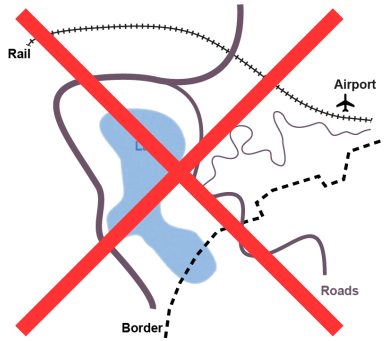
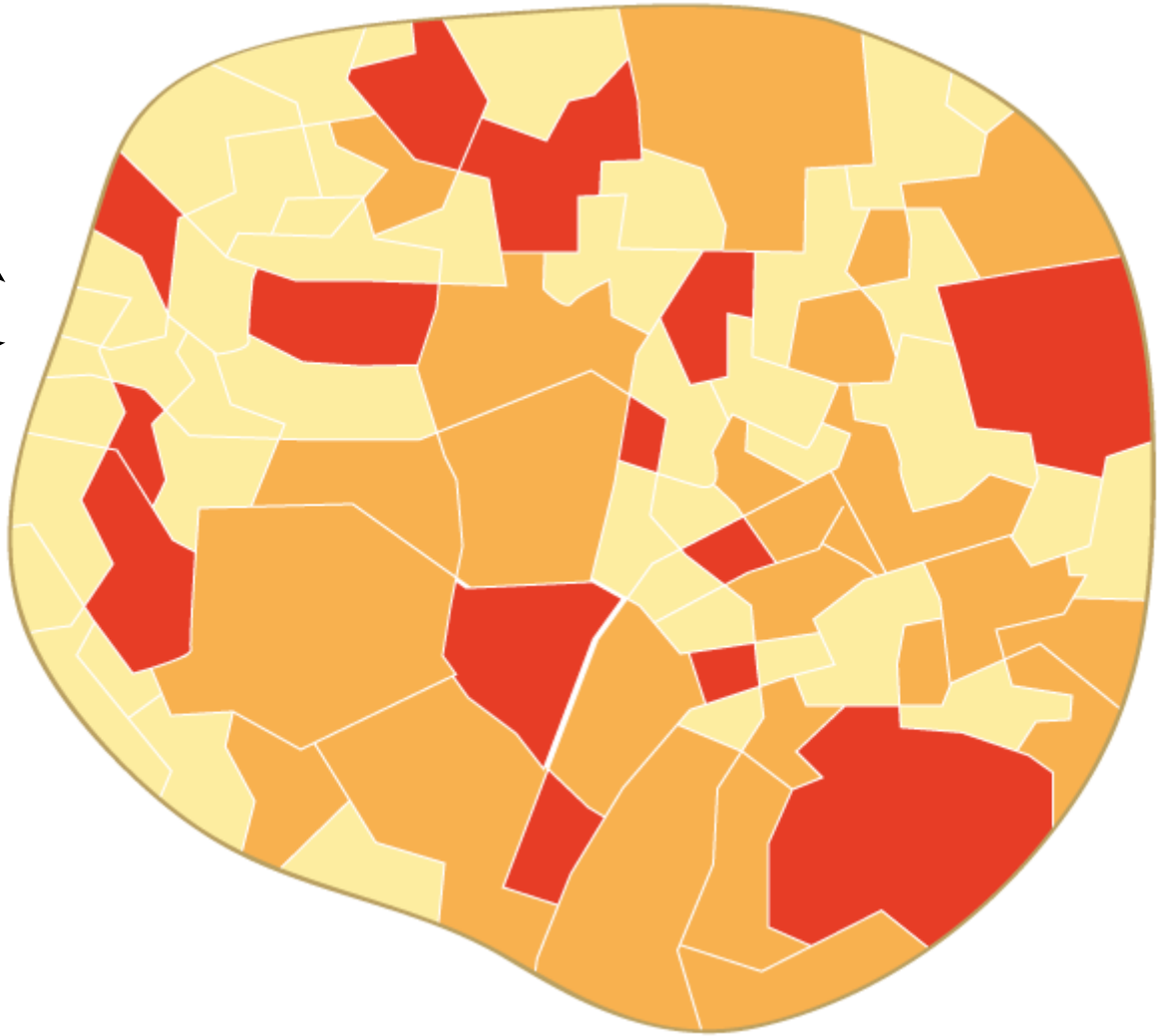
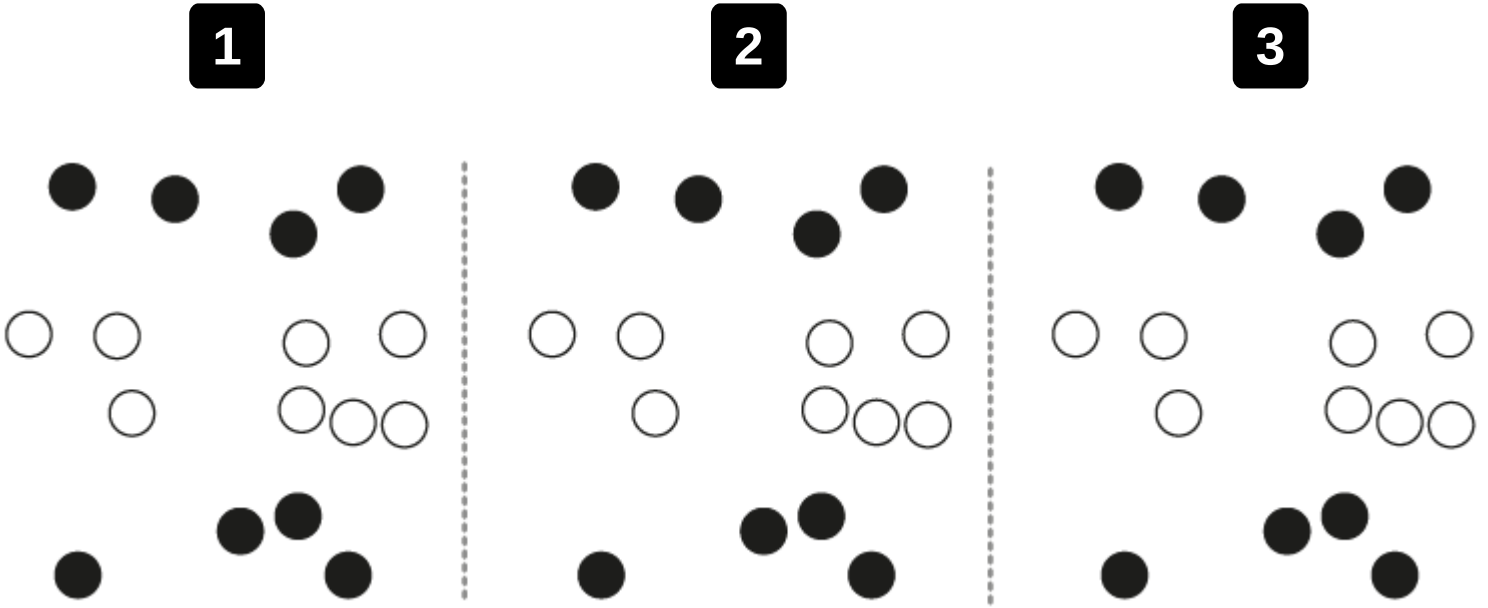


NATURAL AND
ANTHROPIC FEATURES



Choropleth Maps

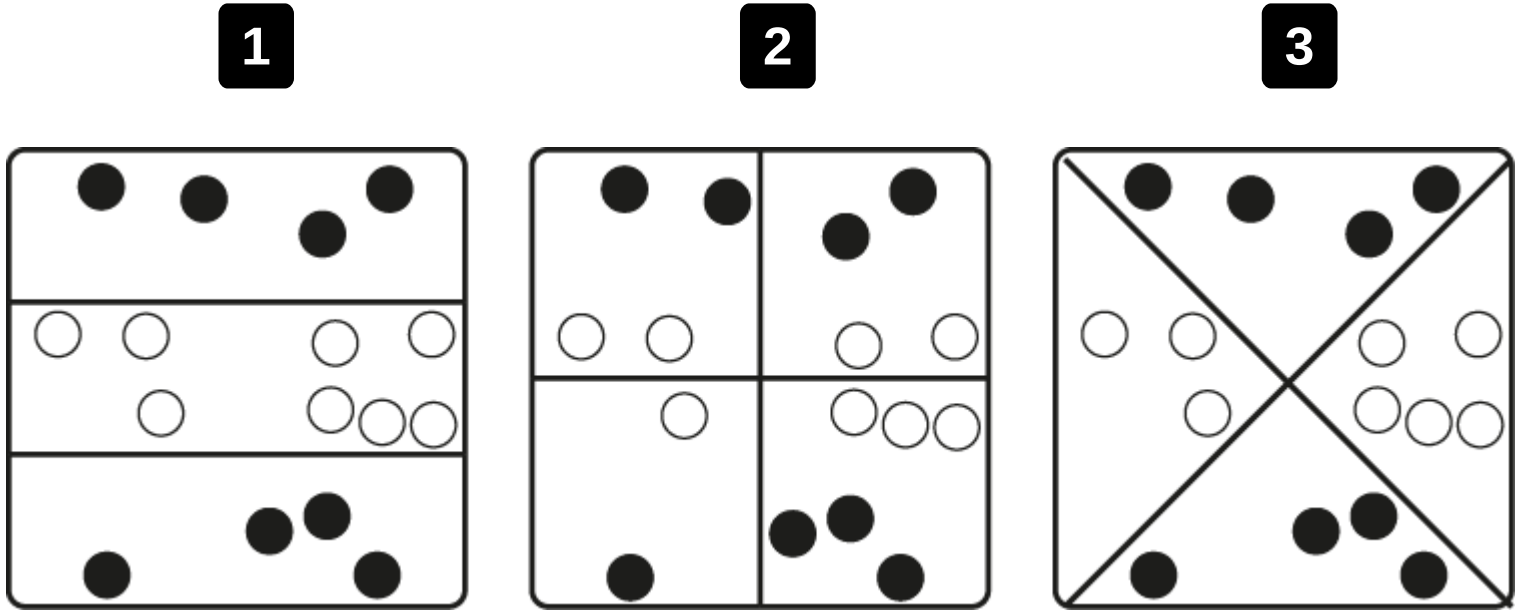
MAUP (Modifiable Area Unit Problem)



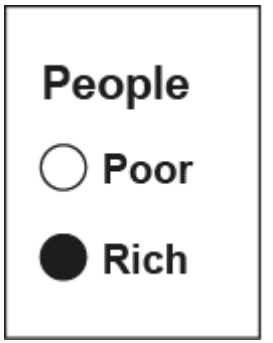
Same reality

People
Poor
Rich

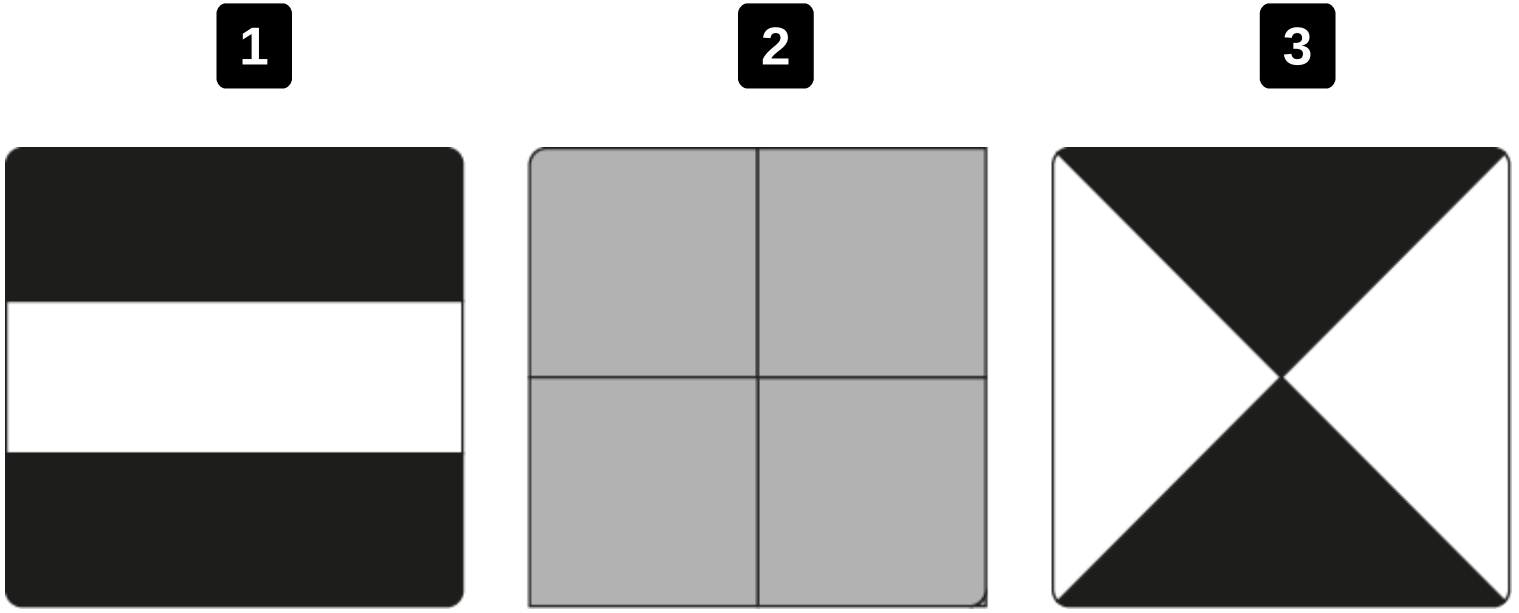
MAUP (Modifiable Area Unit Problem)



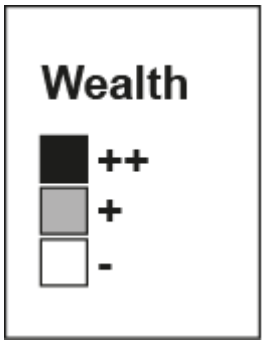
Several grids



MAUP (Modifiable Area Unit Problem)



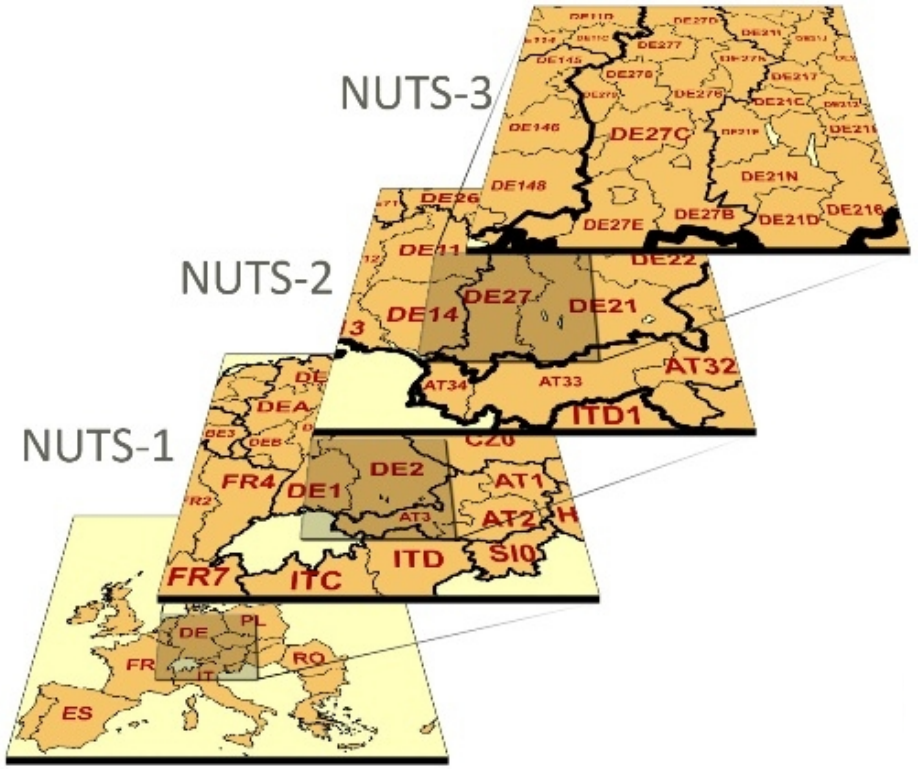
Different maps
& cartographical
messages

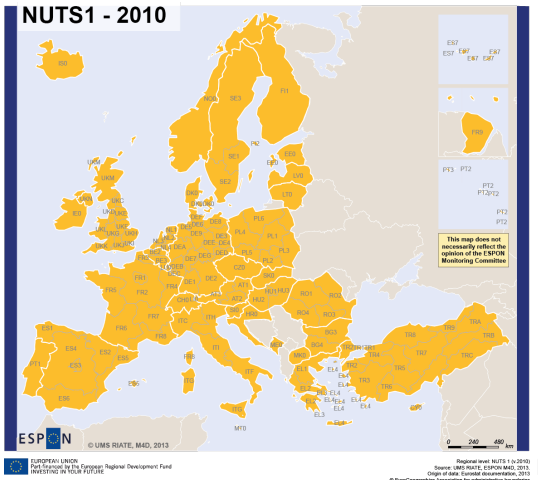


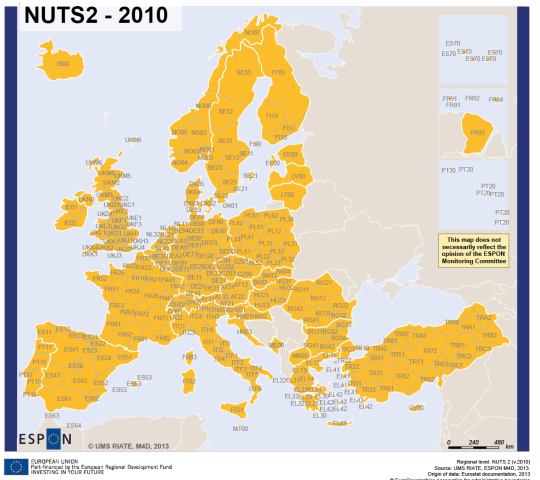
MAUP (Modifiable Area Unit Problem)

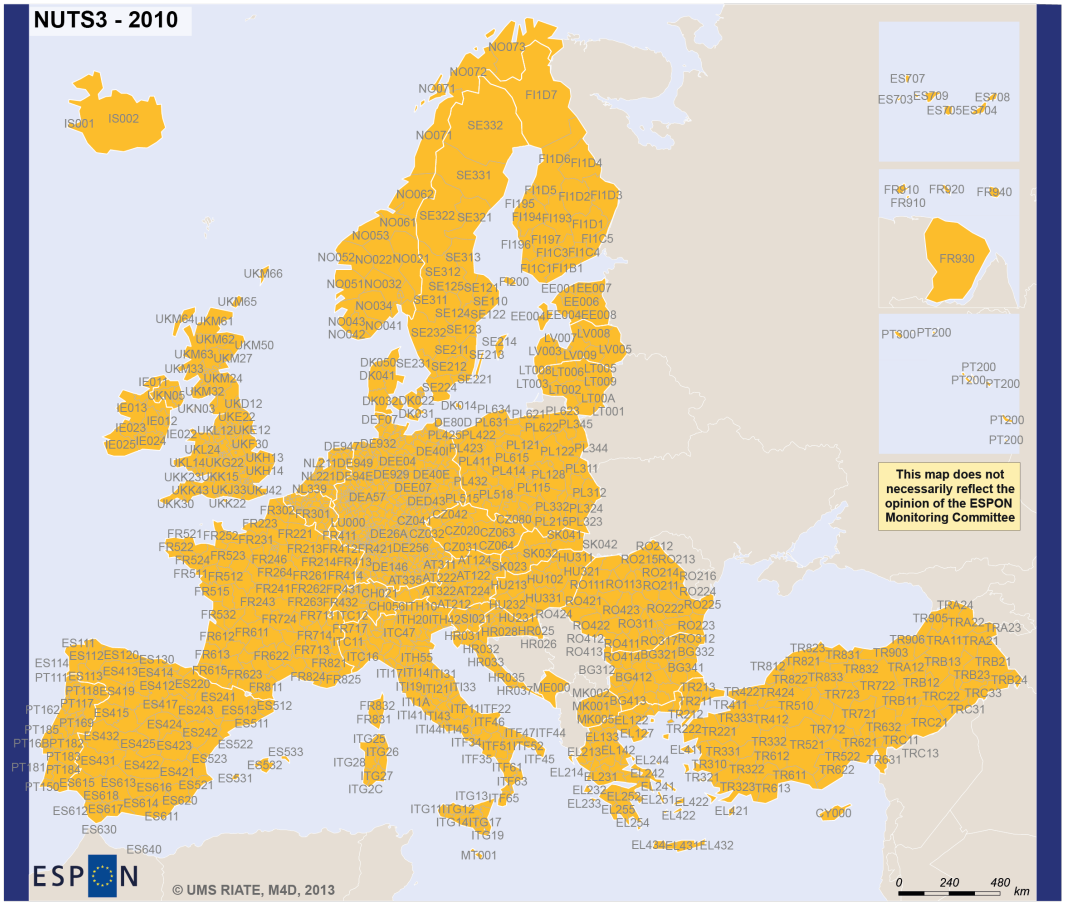
The MAUP in Europe

The NUTS nomenclature









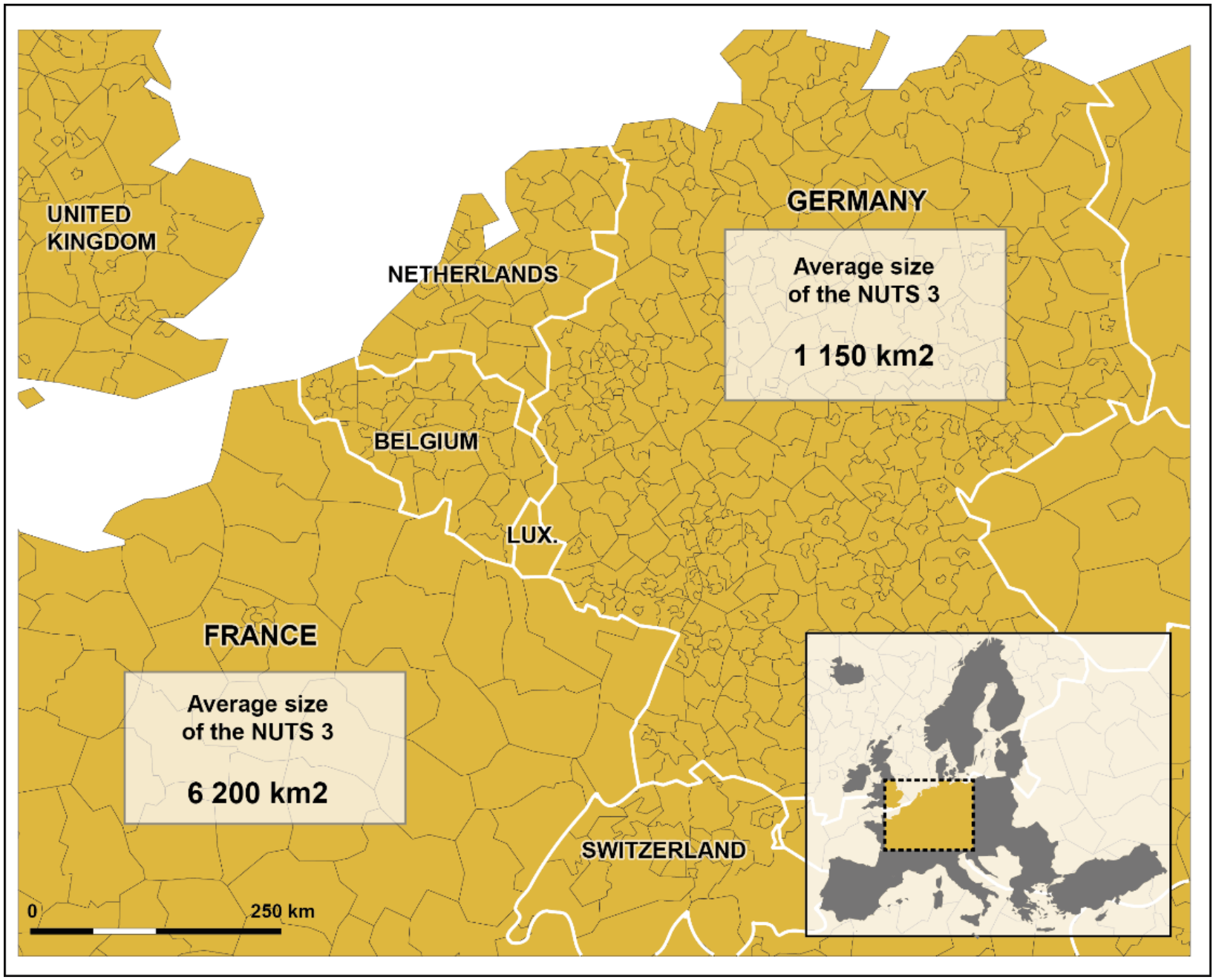
EUROPEAN UNION
Part-financed by the European Regional Development Fund
INVESTING IN YOUR FUTURE

Regional level: NUTS 3 (v.2010)
Source: UMS RIATE, ESPON M4D, 2013.
Origin of data: Eurostat documentation, 2013
© EuroGeographics Association for administrative boundaries

MAUP (Modifiable Area Unit Problem)

The MAUP in Europe

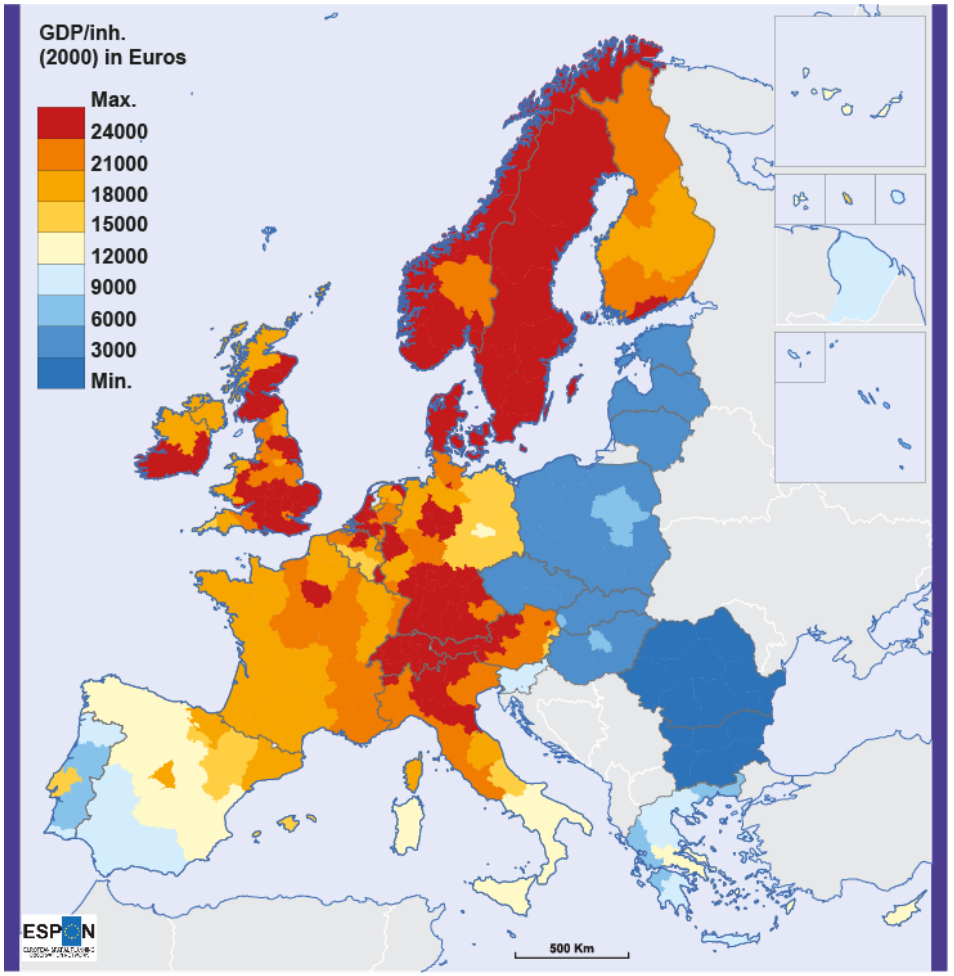
The NUTS nomenclature



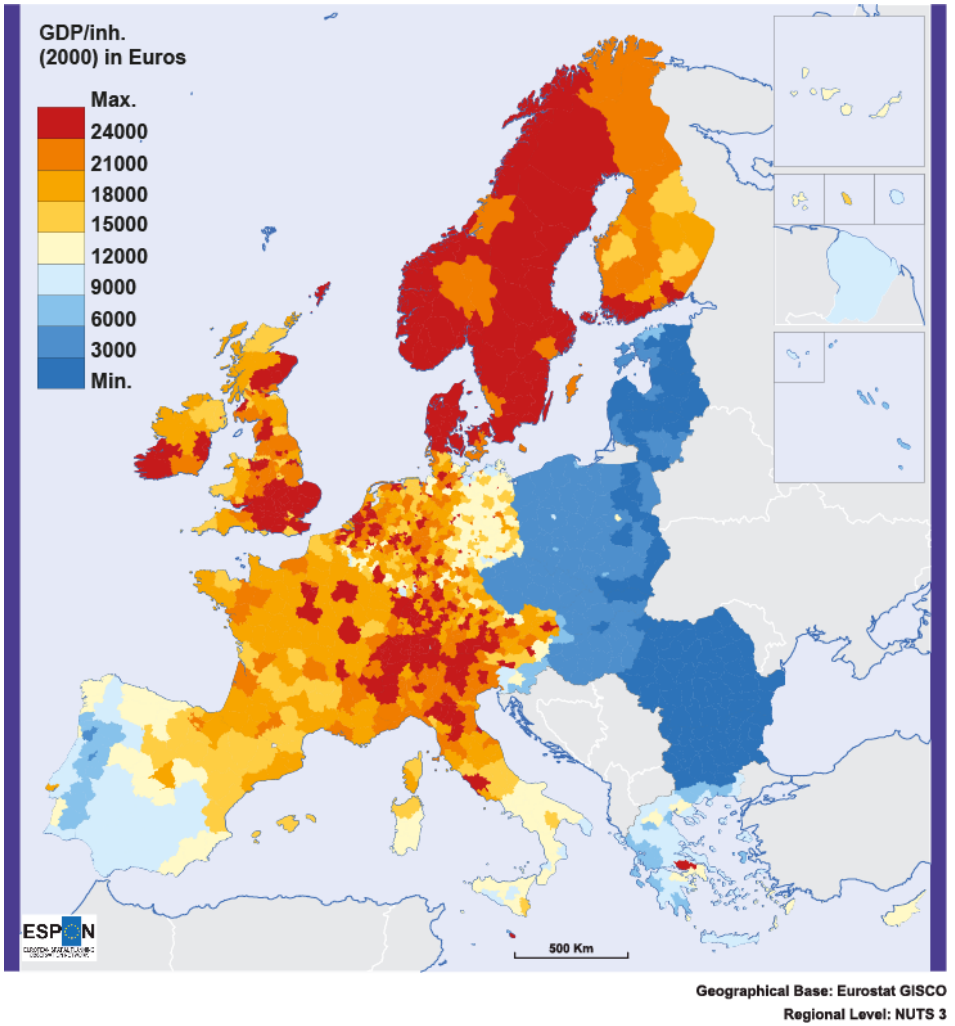
MAUP (Modifiable Area Unit Problem)

The MAUP in Europe

GDP per inh. In 2000



NUTS 2

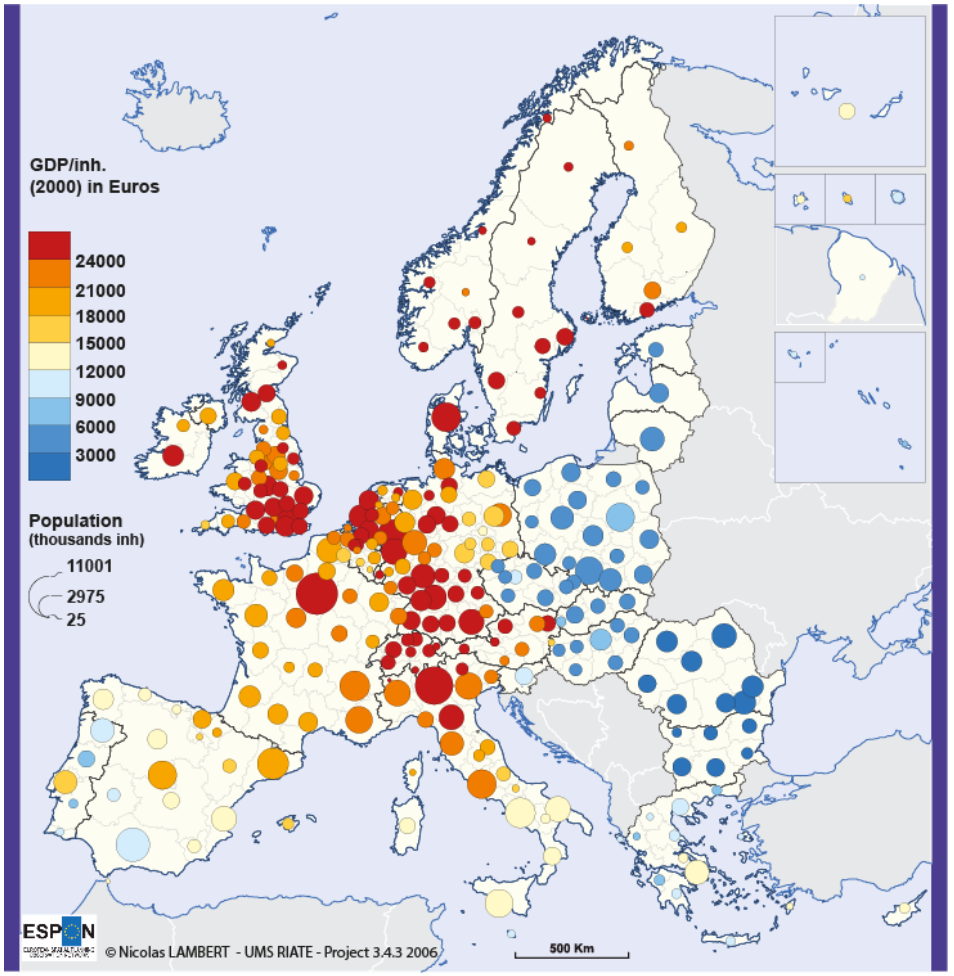


NUTS 3

MAUP (Modifiable Area Unit Problem)

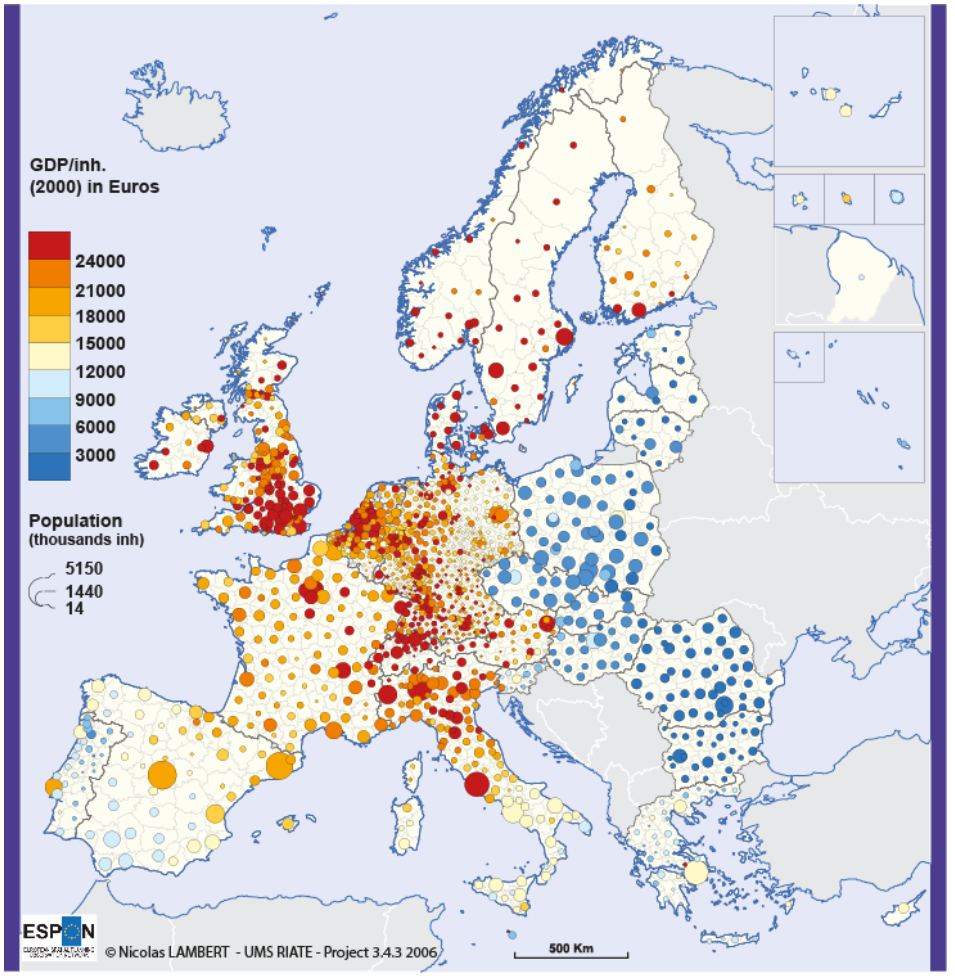
How to solve it?

Cartography of ratio and visualisation of denominator



Geographical Base: Eurostat GISCO
Regional Level: Nuts 2

NUTS 2



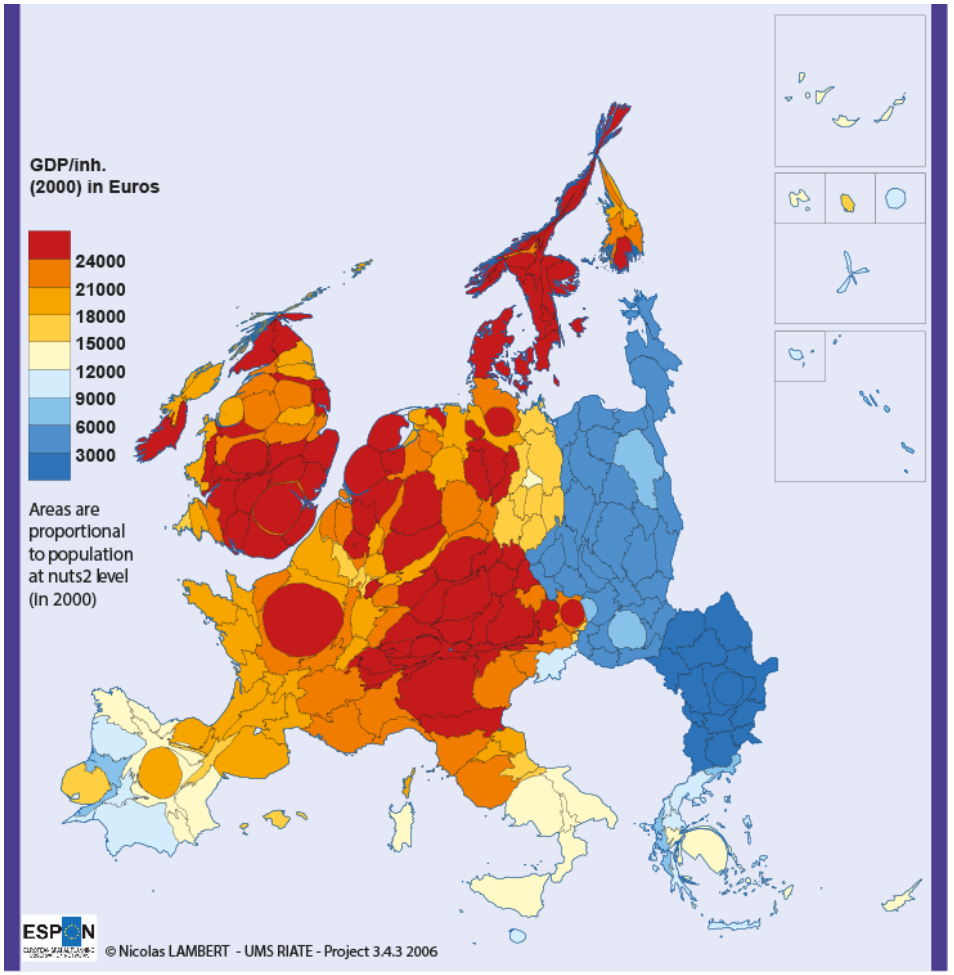
Geographical Base: Eurostat GISCO
Regional Level: Nuts 2

NUTS 3

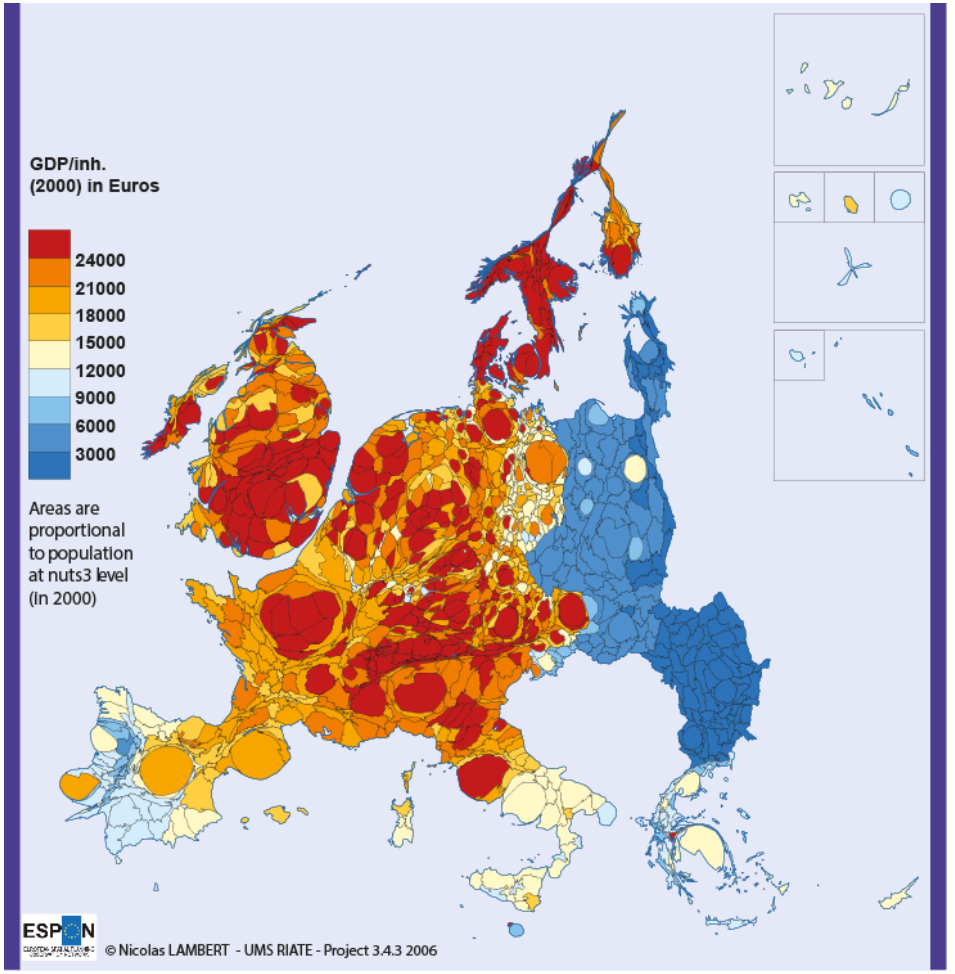
MAUP (Modifiable Area Unit Problem)

How to solve it?

Cartograms as solution to the MAUP



NUTS 2



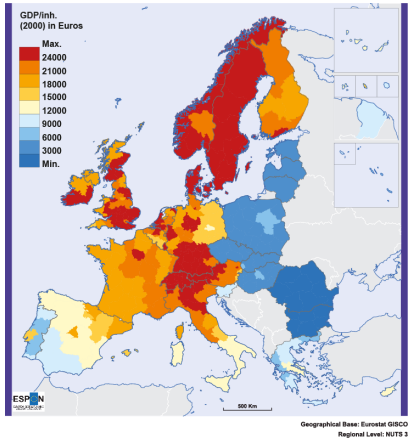
NUTS 3

MAUP (Modifiable Area Unit Problem)

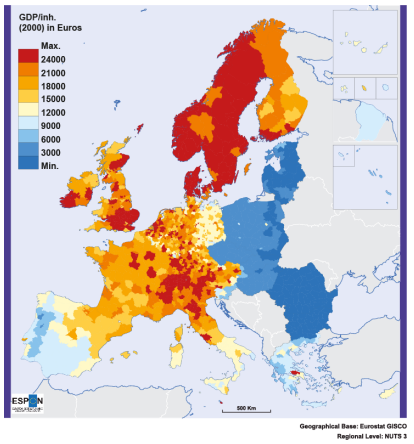
How to solve it?

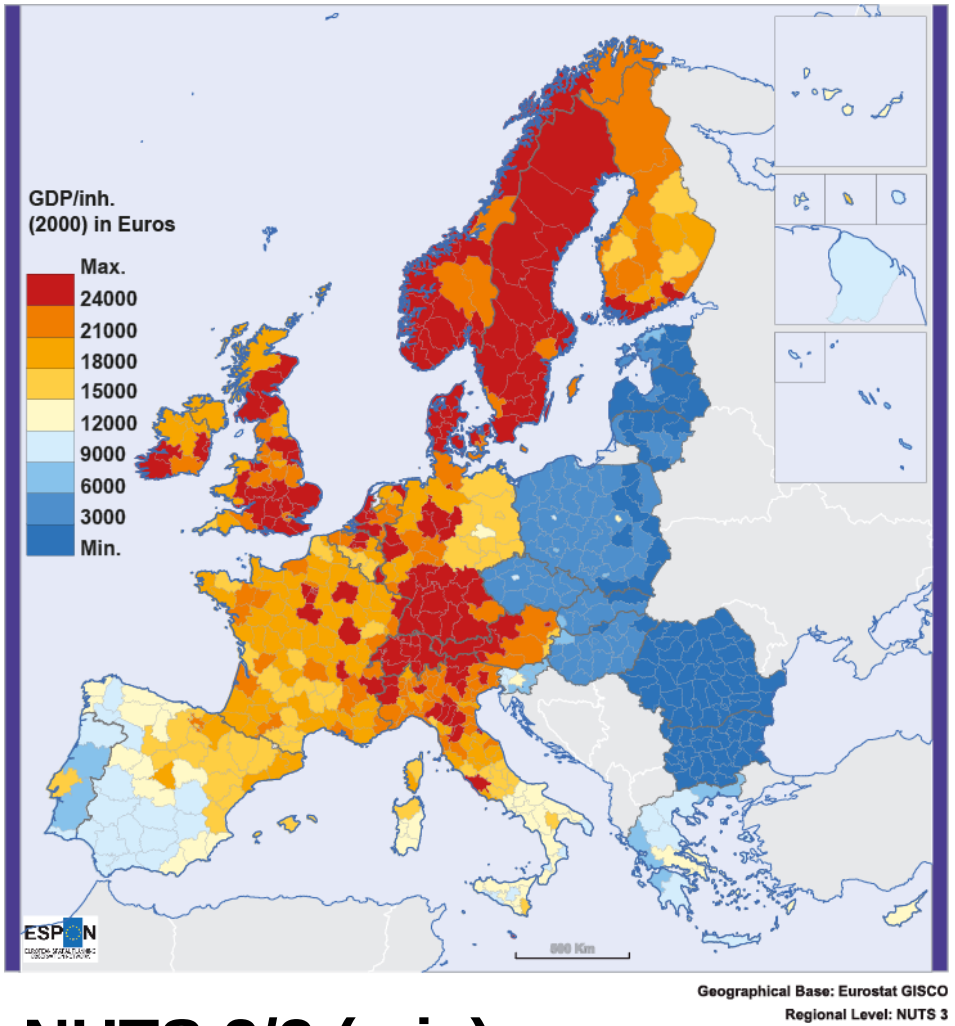
Aggregation of administrative boundaries (e.g NUTS 2-3)

NUTS 2



NUTS 3



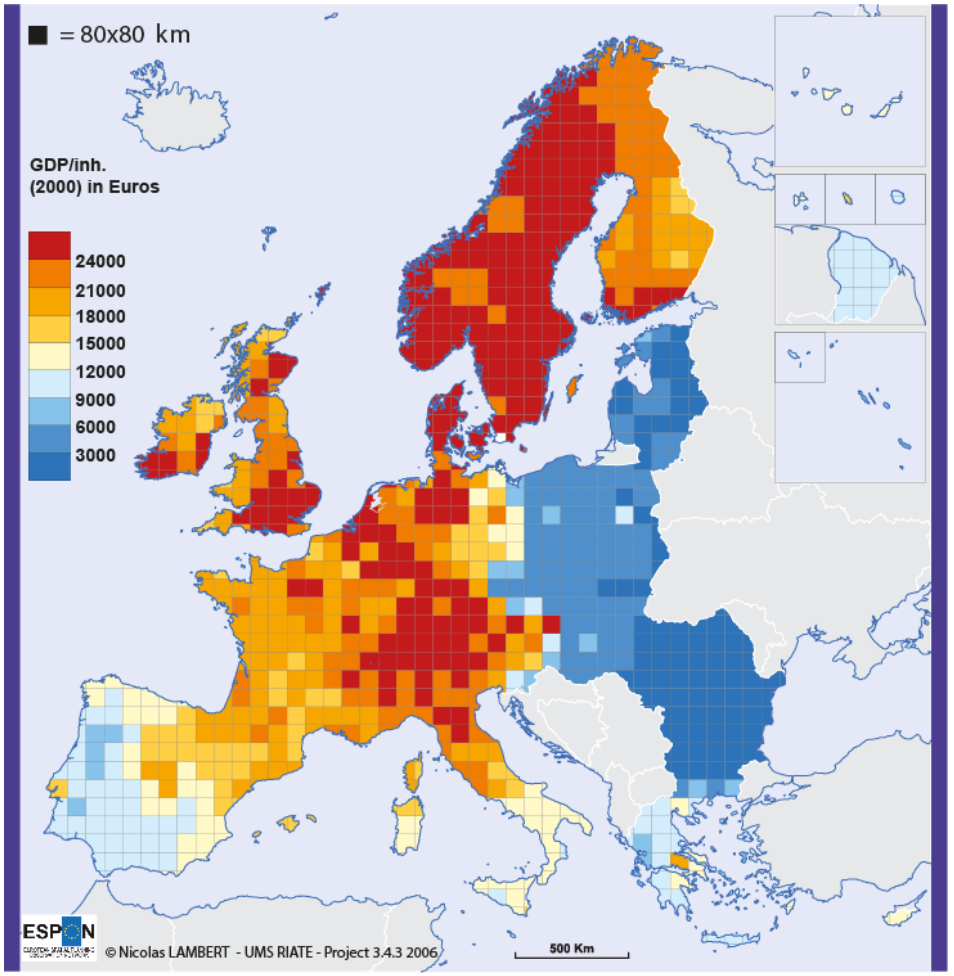


NUTS 2/3 (mix)

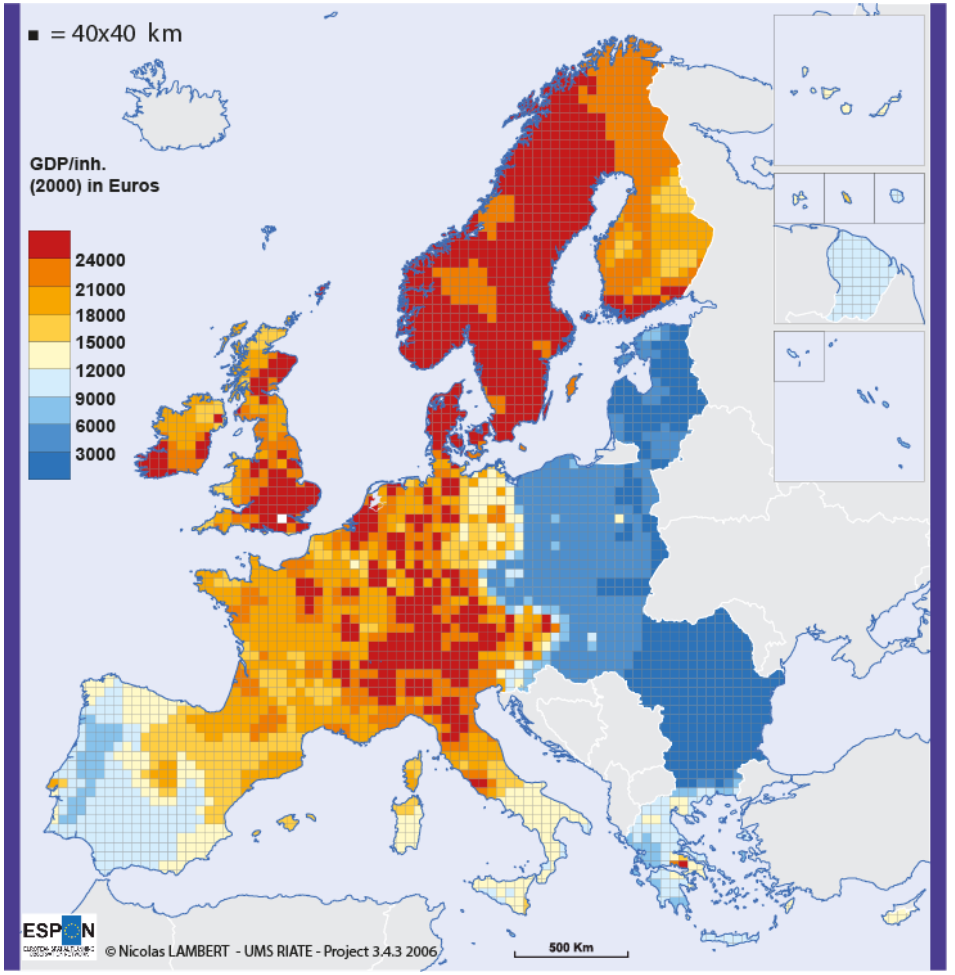
MAUP (Modifiable Area Unit Problem)

How to solve it?

Gridding methods



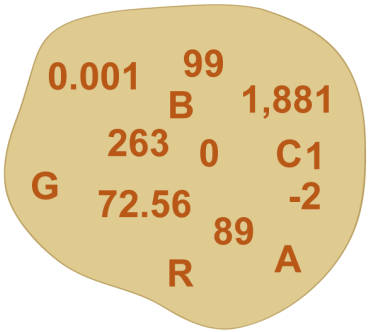
80x80 km



40x40 km

MAUP (Modifiable Area Unit Problem)

A better approach



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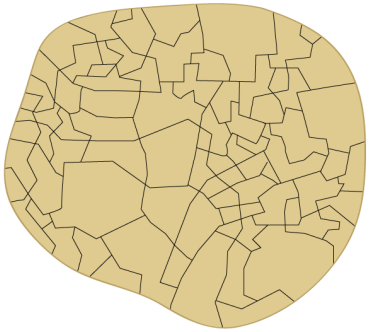

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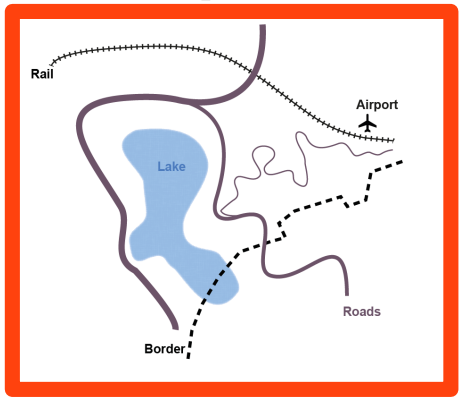
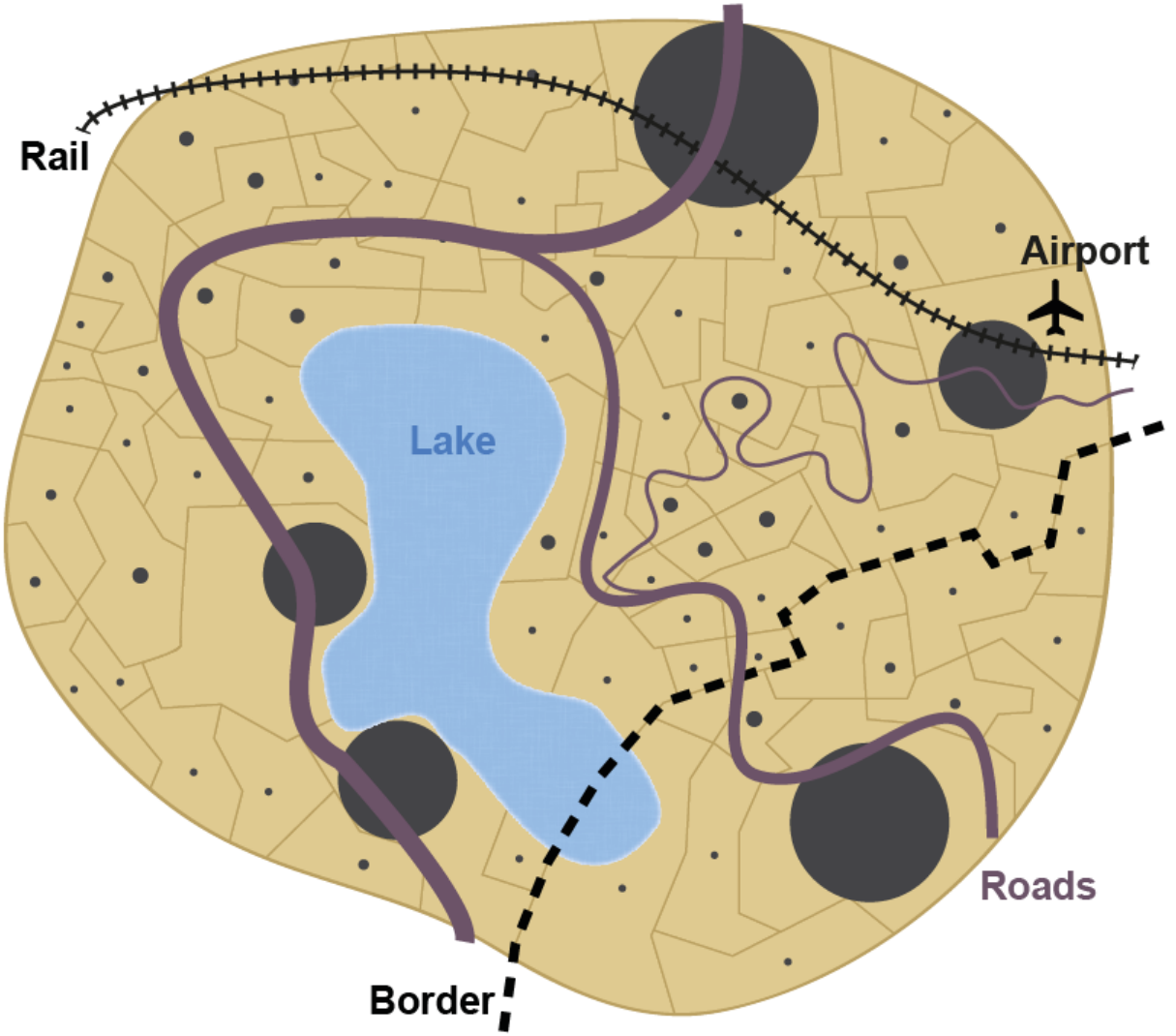
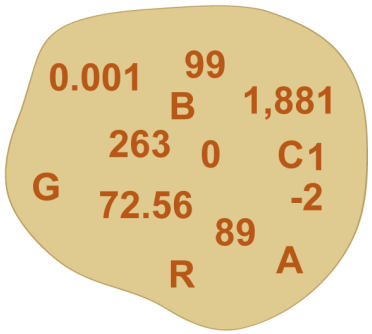




Functional Indicators

spatial interaction modeling



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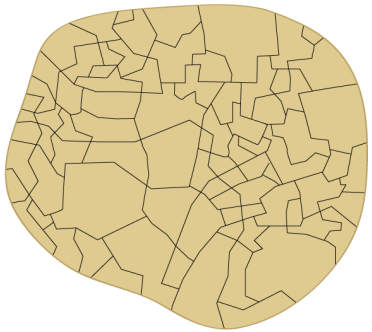

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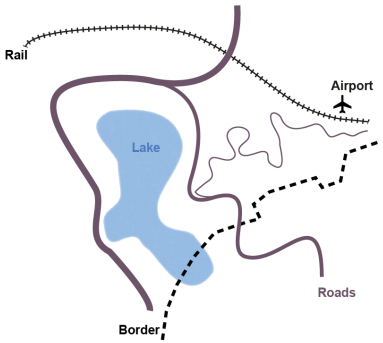
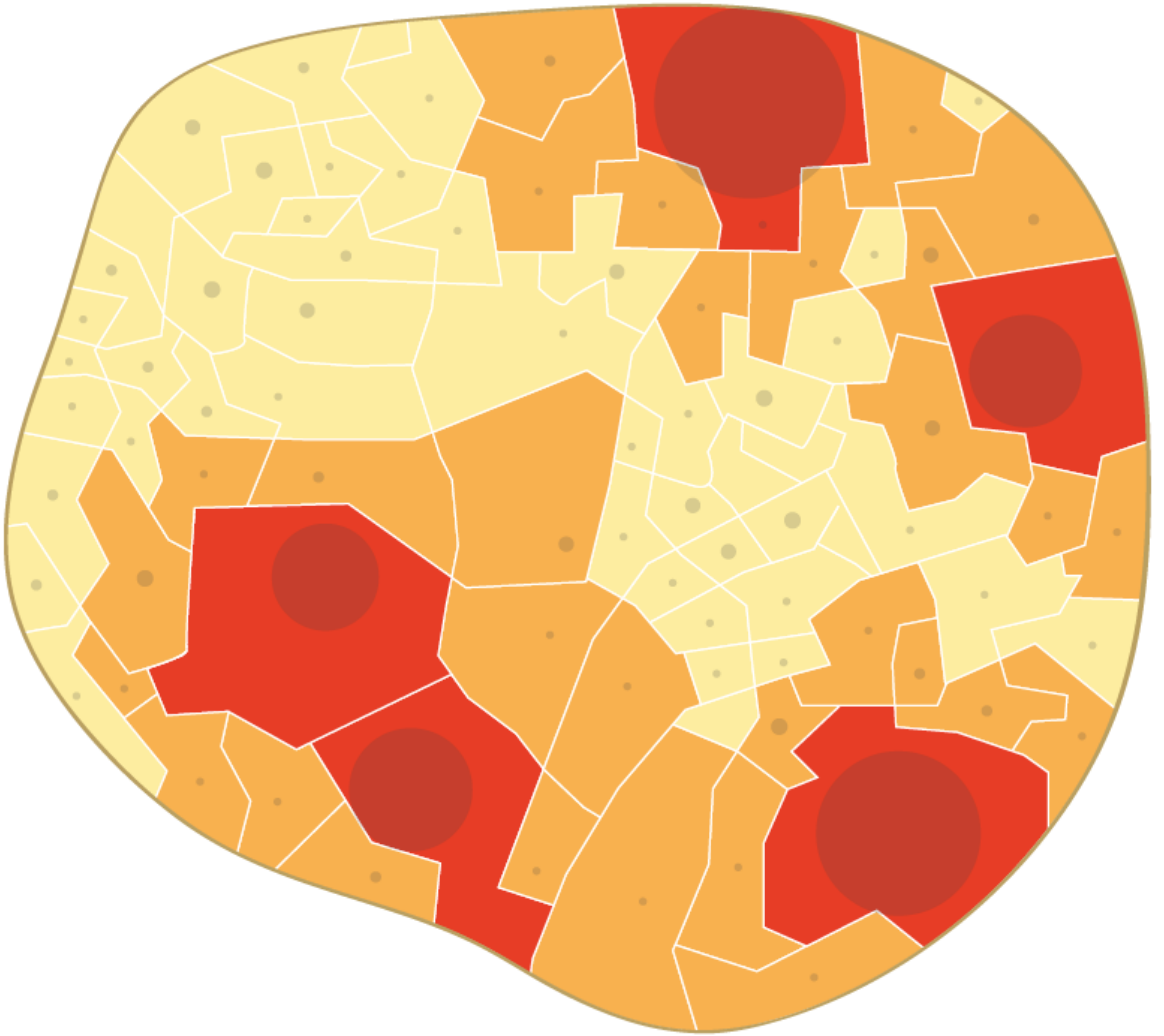
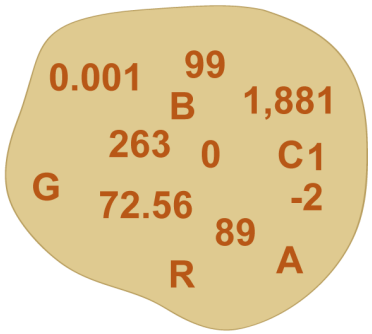




Euclidan distance

Functional Indicators

spatial interaction modeling



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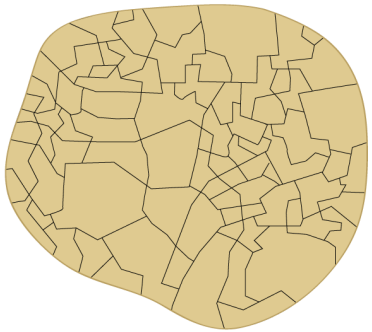

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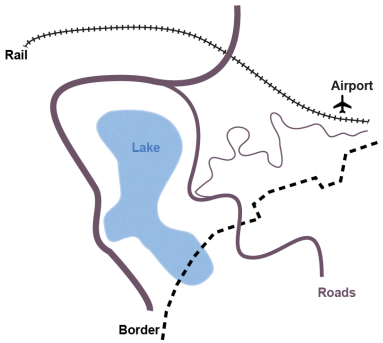
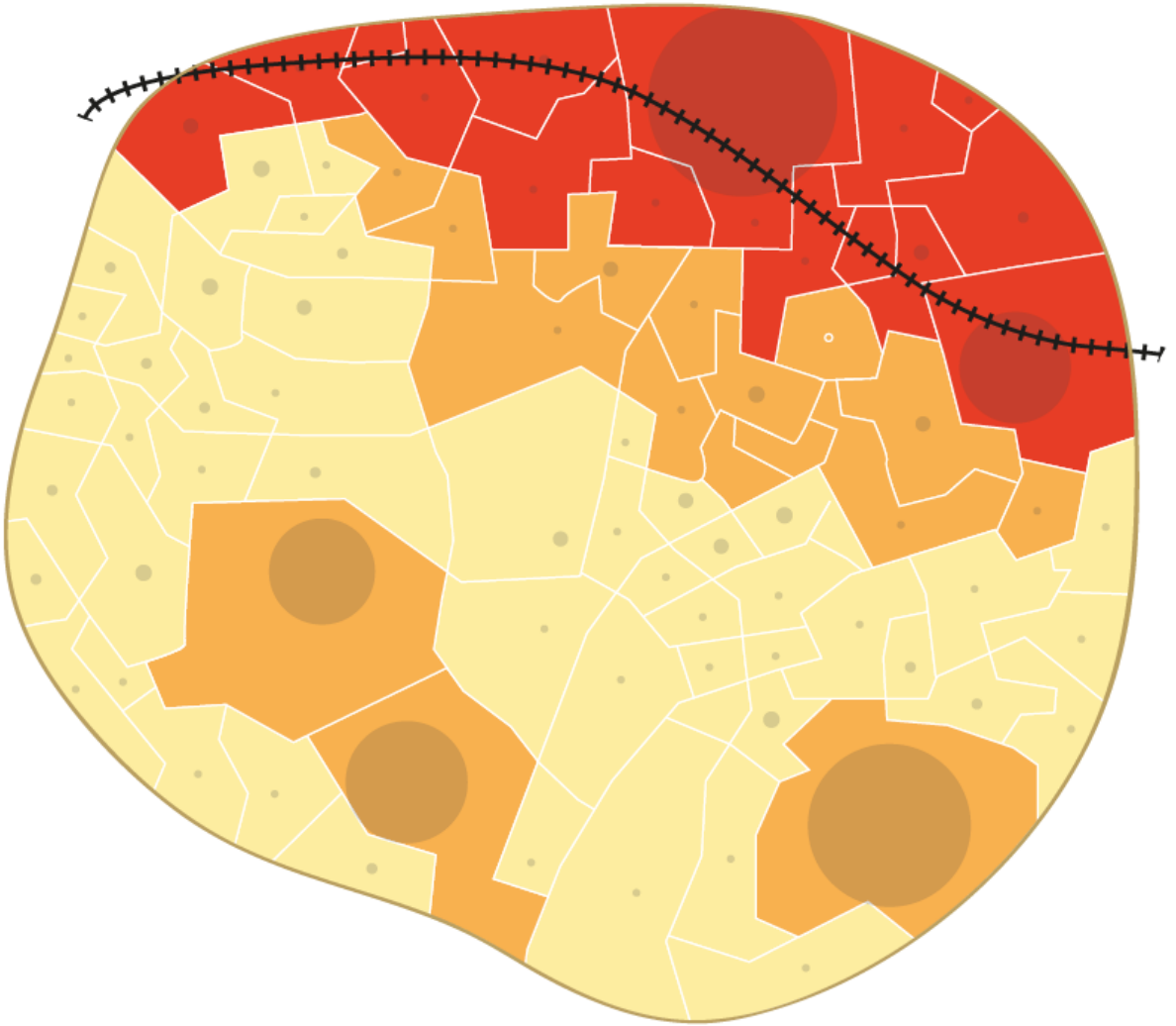
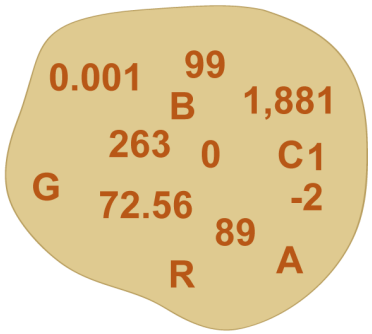




Rail distance

Functional Indicators

spatial interaction modeling



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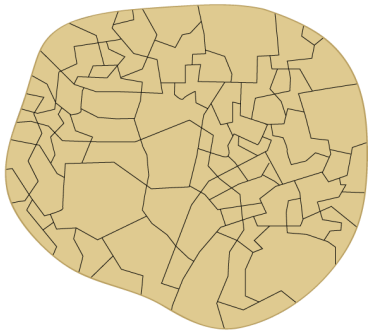

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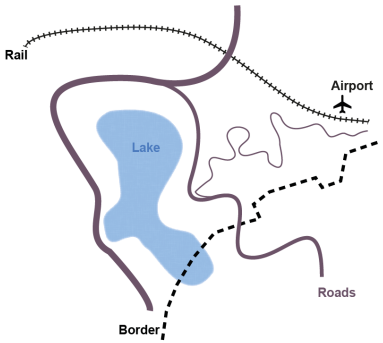
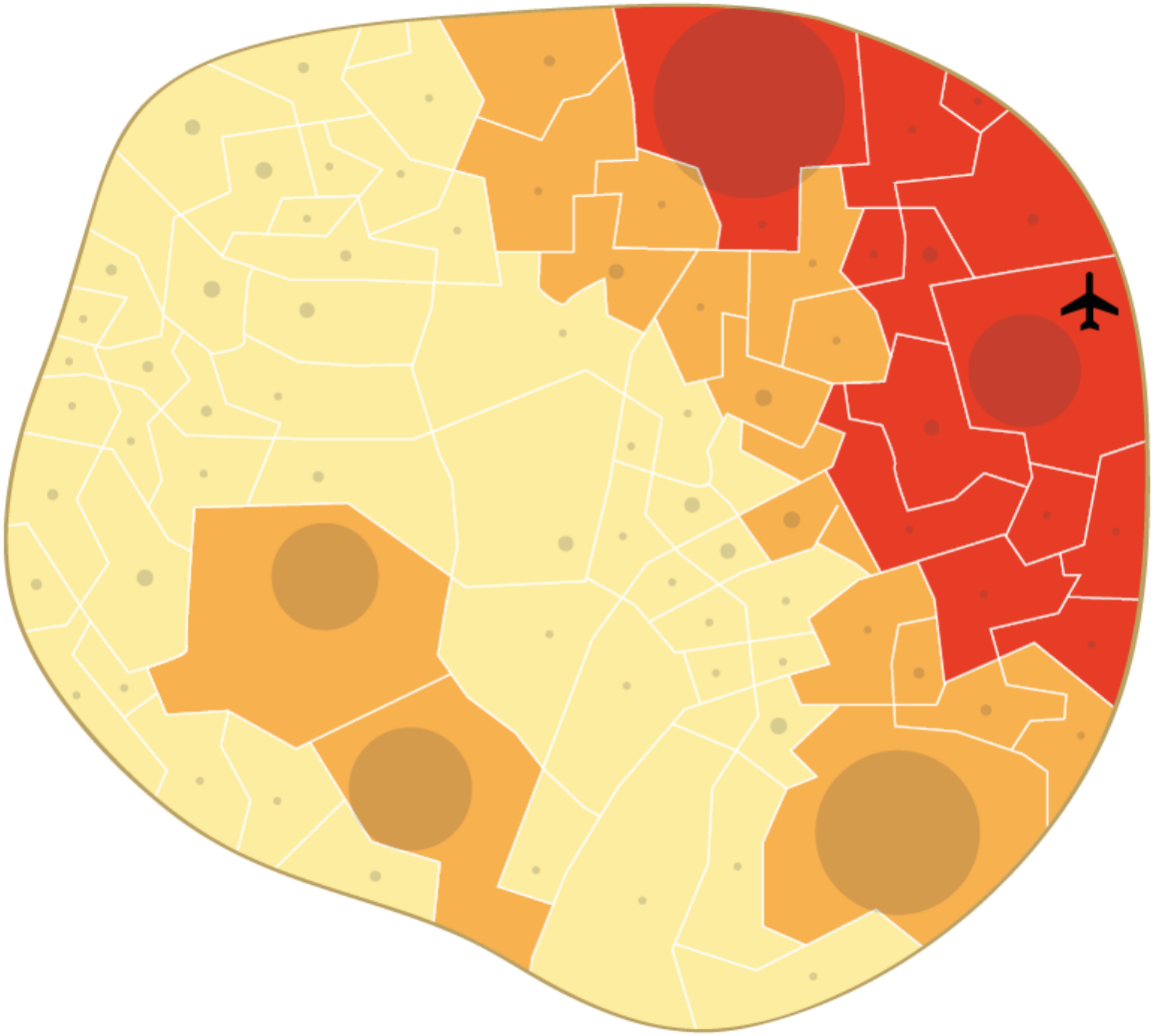
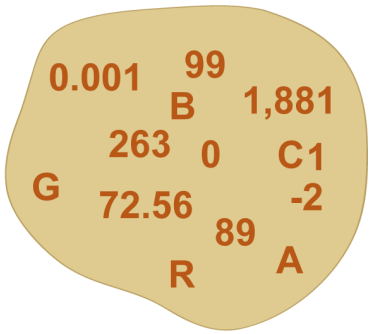




Air distance

Functional Indicators

spatial interaction modeling



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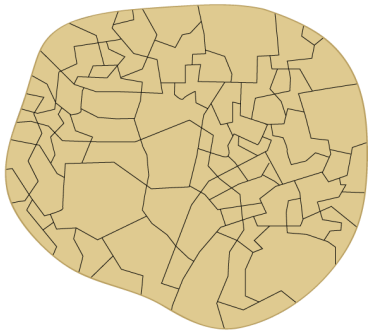

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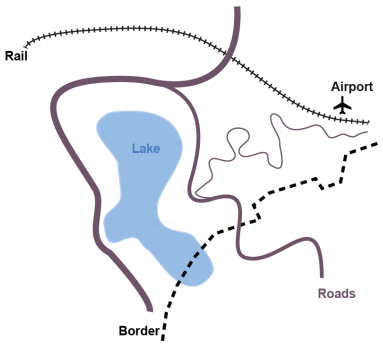
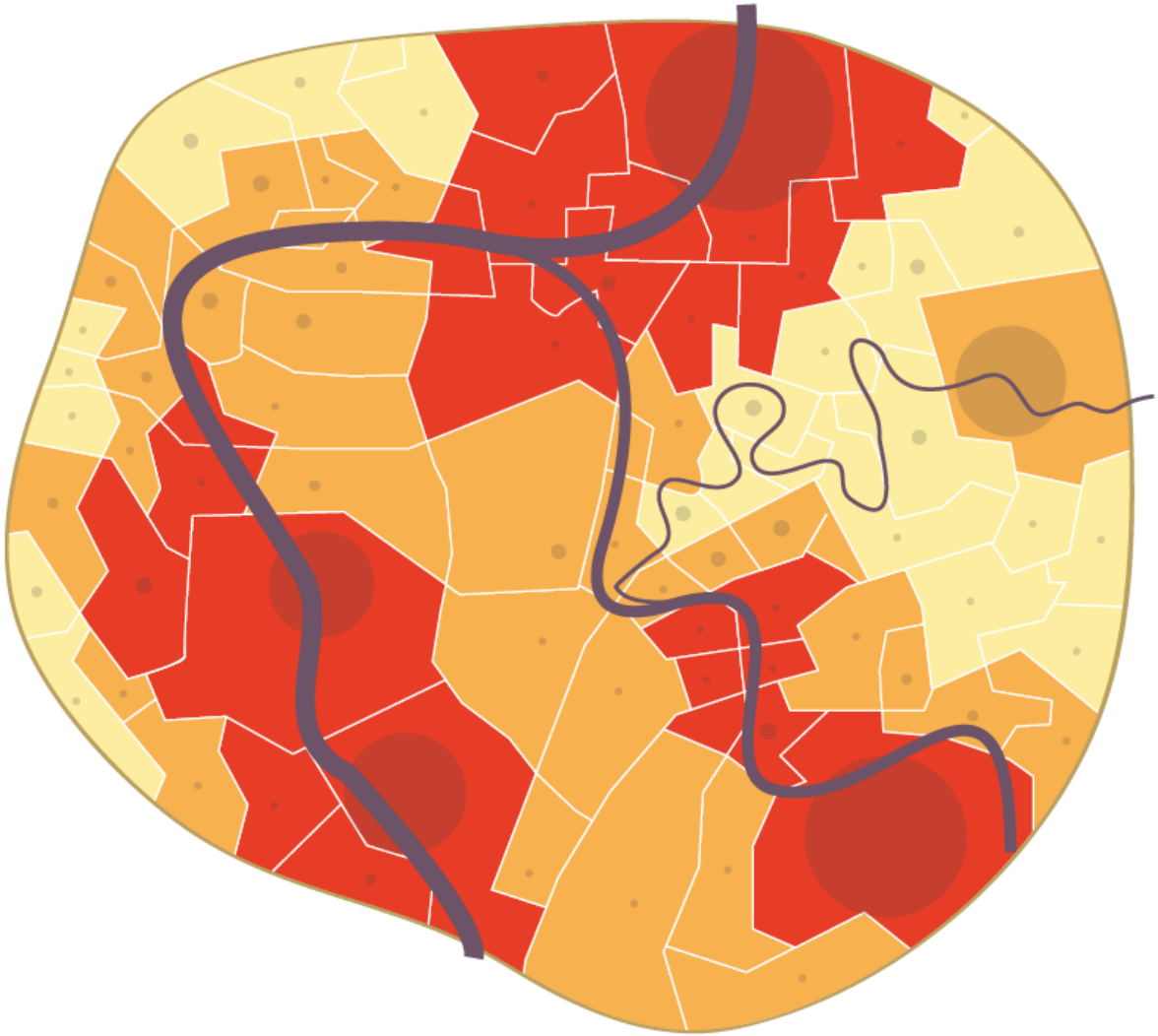
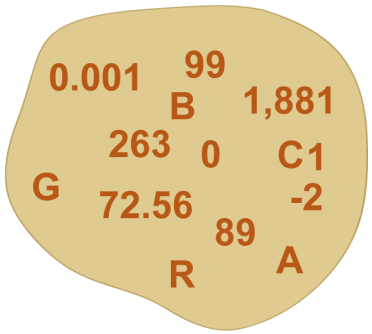




Road distance

Functional Indicators

spatial interaction modeling



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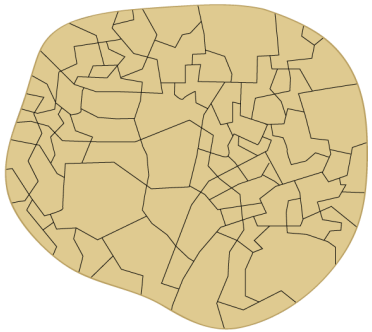

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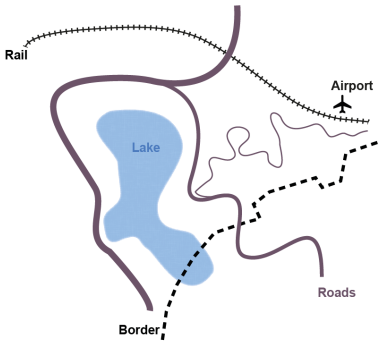
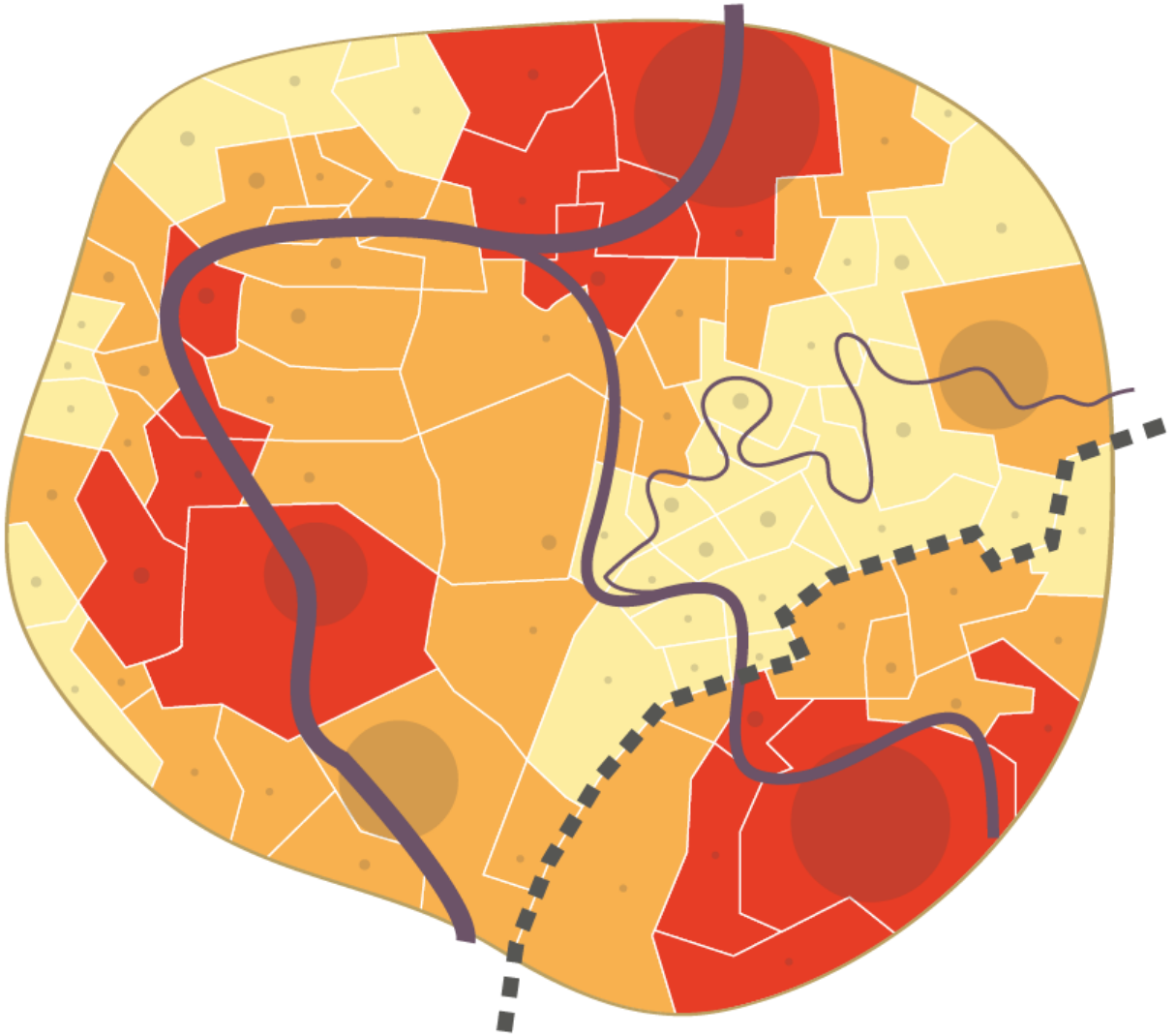




Road distance + border

Functional Indicators

spatial interaction modeling

Stewart model (potential access, gravitational potential or gravitational accessibility)

$$A_i = \sum_{j=1}^{n} O_j f(d_{ij})$$

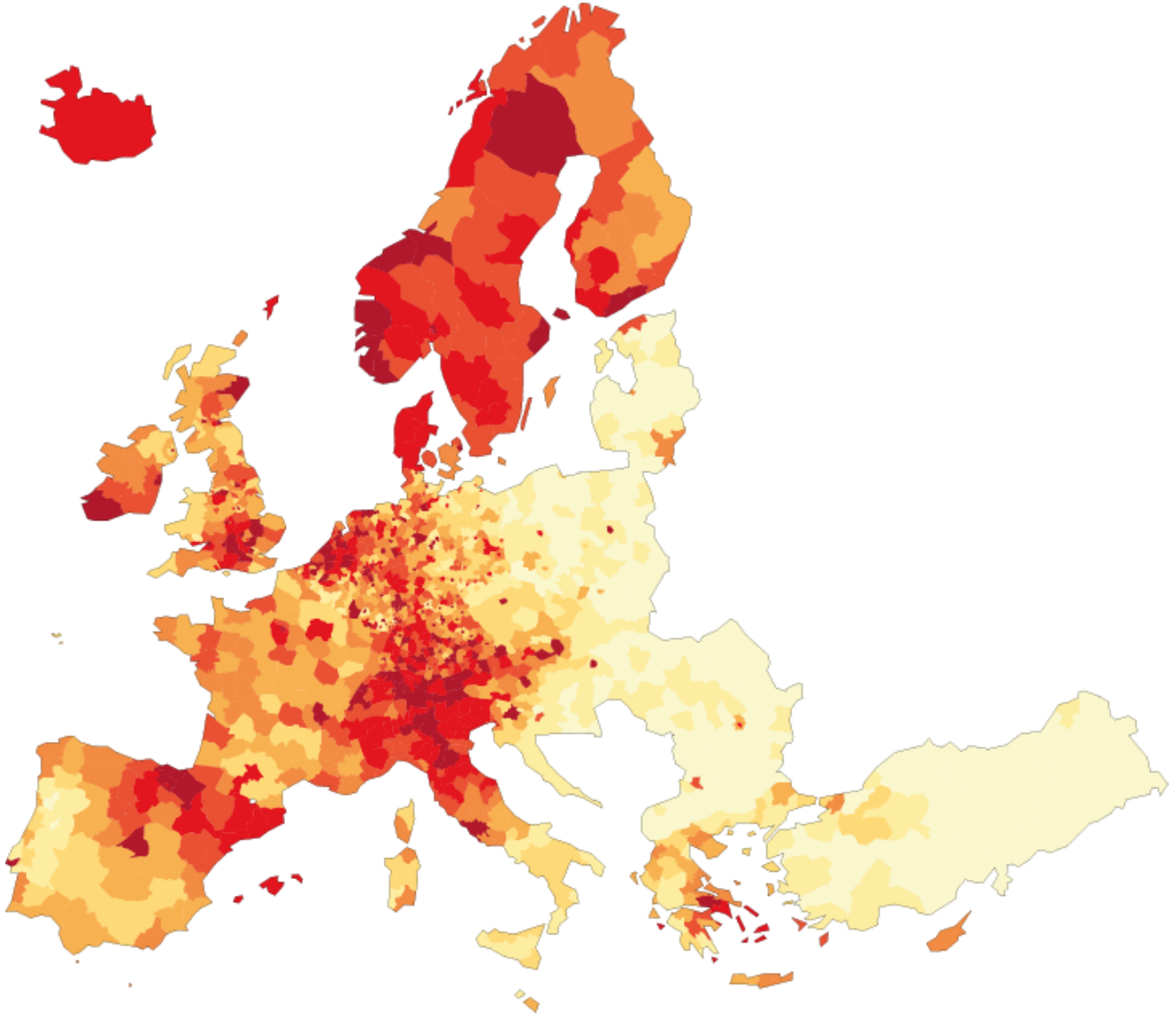
- A_i is the potential at i

- O_j is the stock of population at j

- $f(d_{ij})$ is a negative function of the distance between i and j, mainly of the power or the exponential form.

Functional Indicators

▶ Enhancing spatial paterns

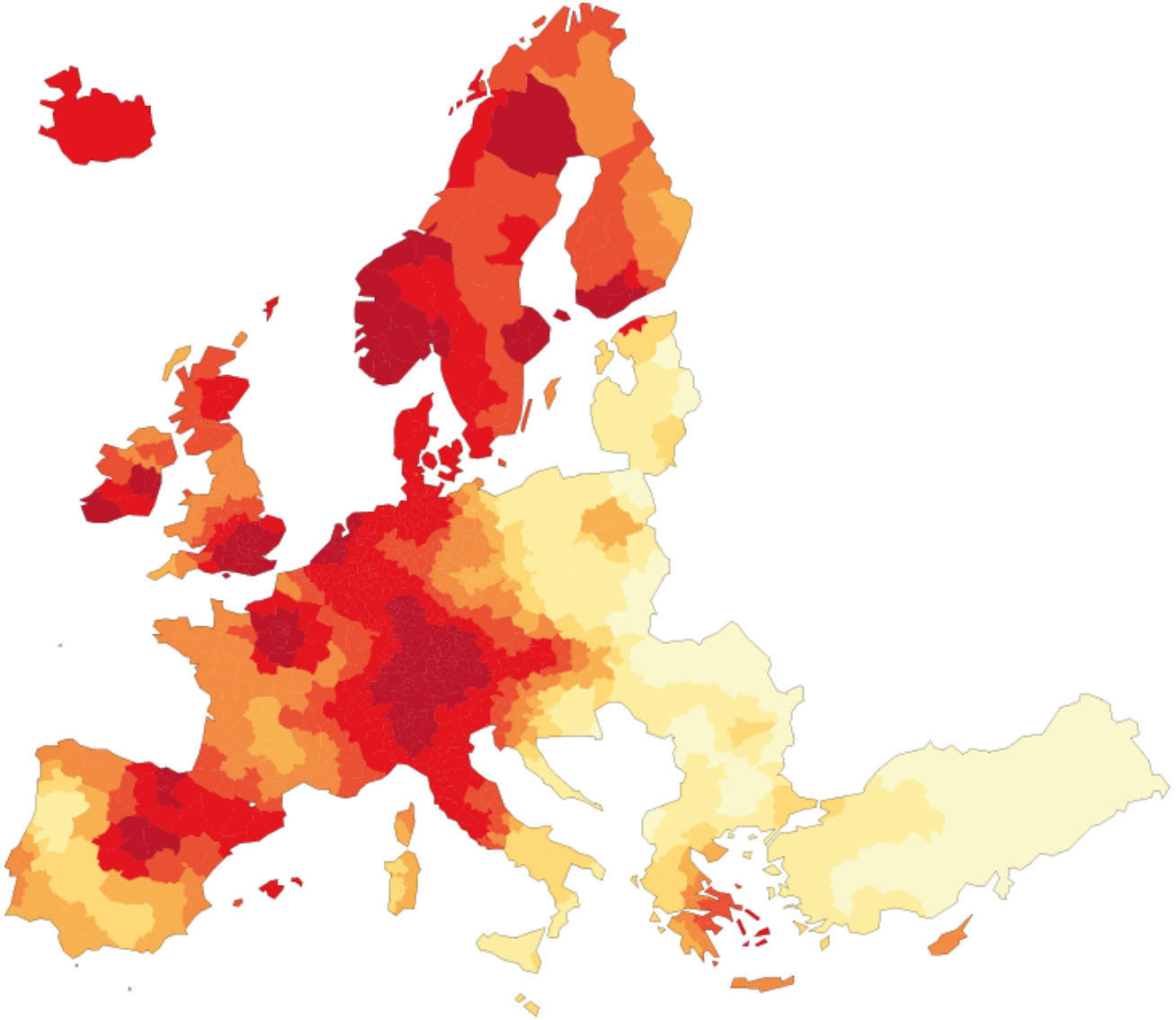


Raw data *(GDP per inh.)*

Raw basemap

Functional Indicators

▶ Enhancing spatial paterns

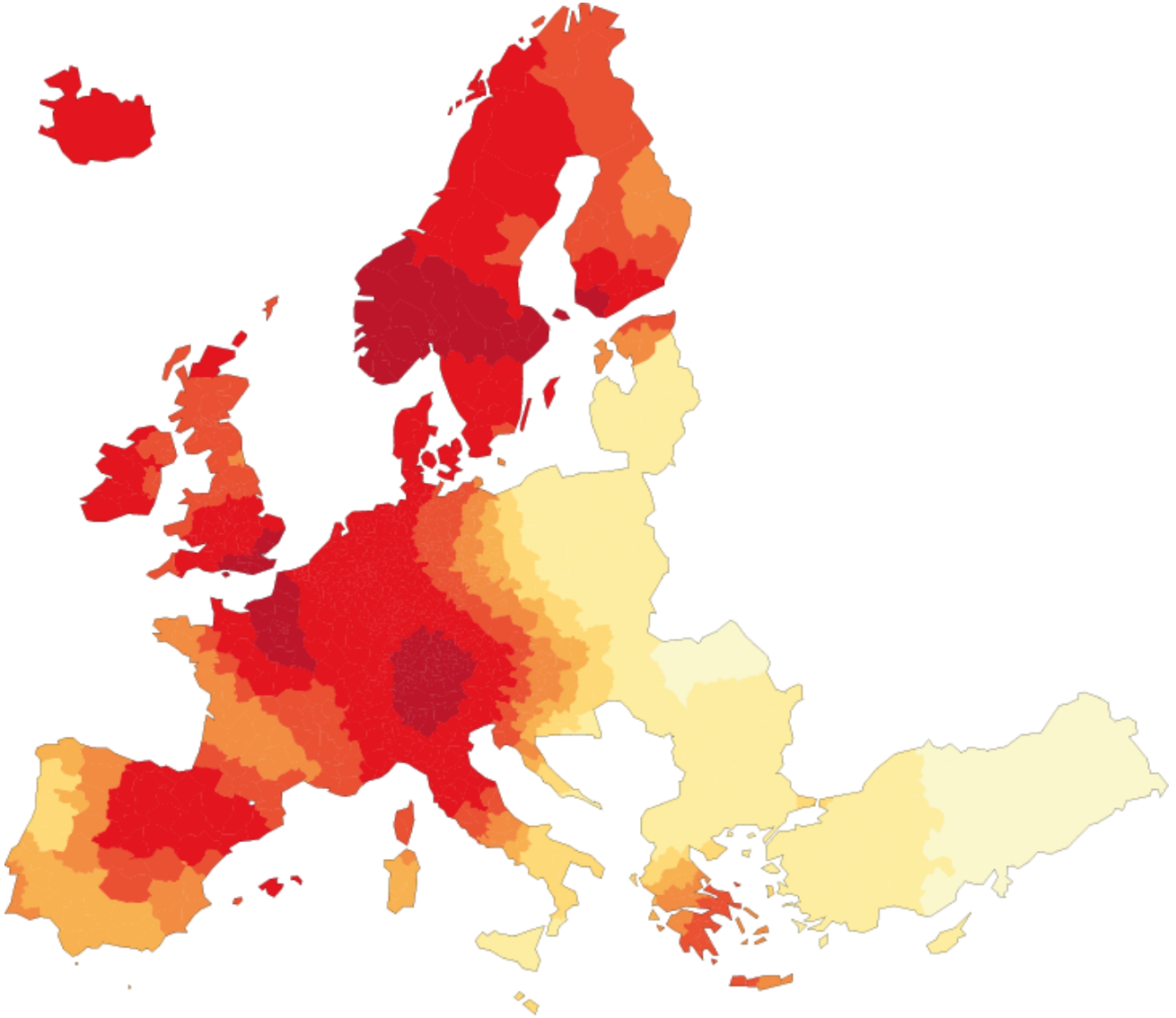


Semantic simplification (100km)

Geometric generalisation (+)

Functional Indicators

Enhancing spatial paterns

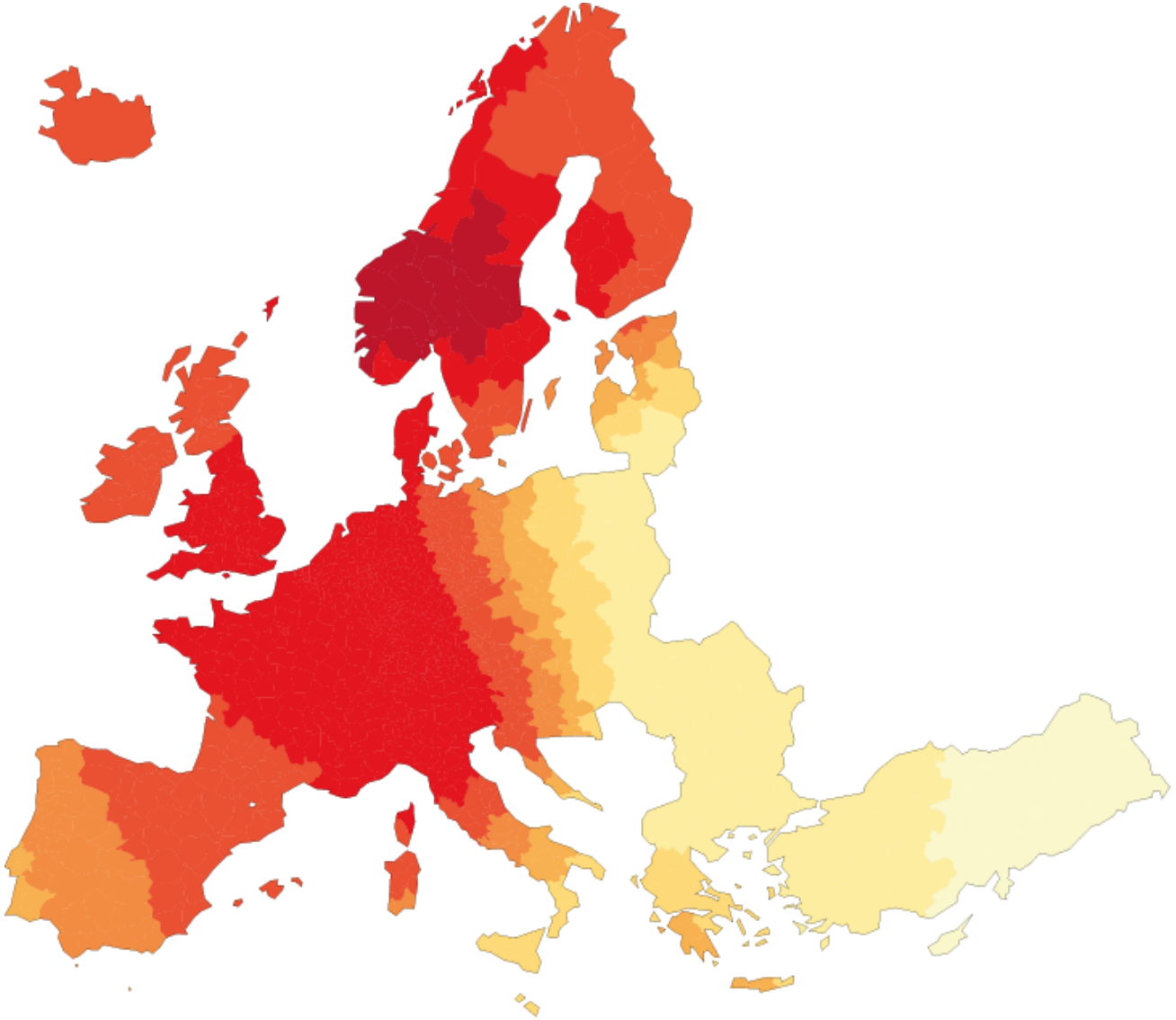


Semantic simplification (200km)

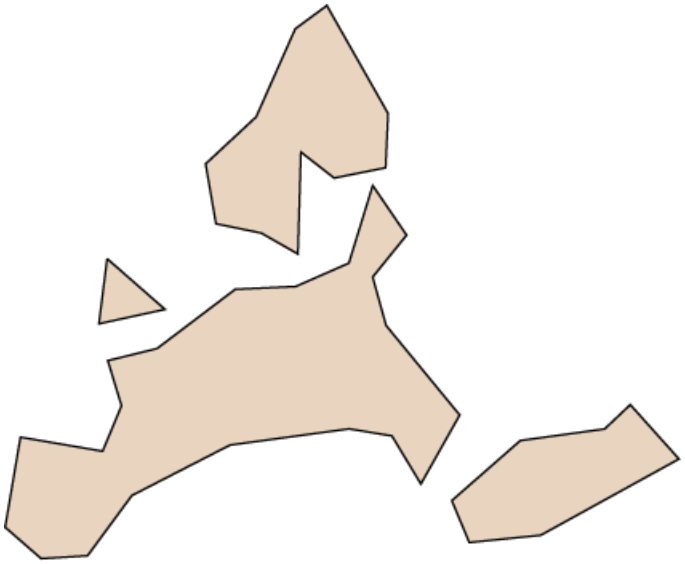
Geometric generalisation (++)

Functional Indicators

▶ Enhancing spatial paterns



Semantic simplification (400km)



Geometric generalisation (+++)

Functional Indicators

Automatic computation and mapping

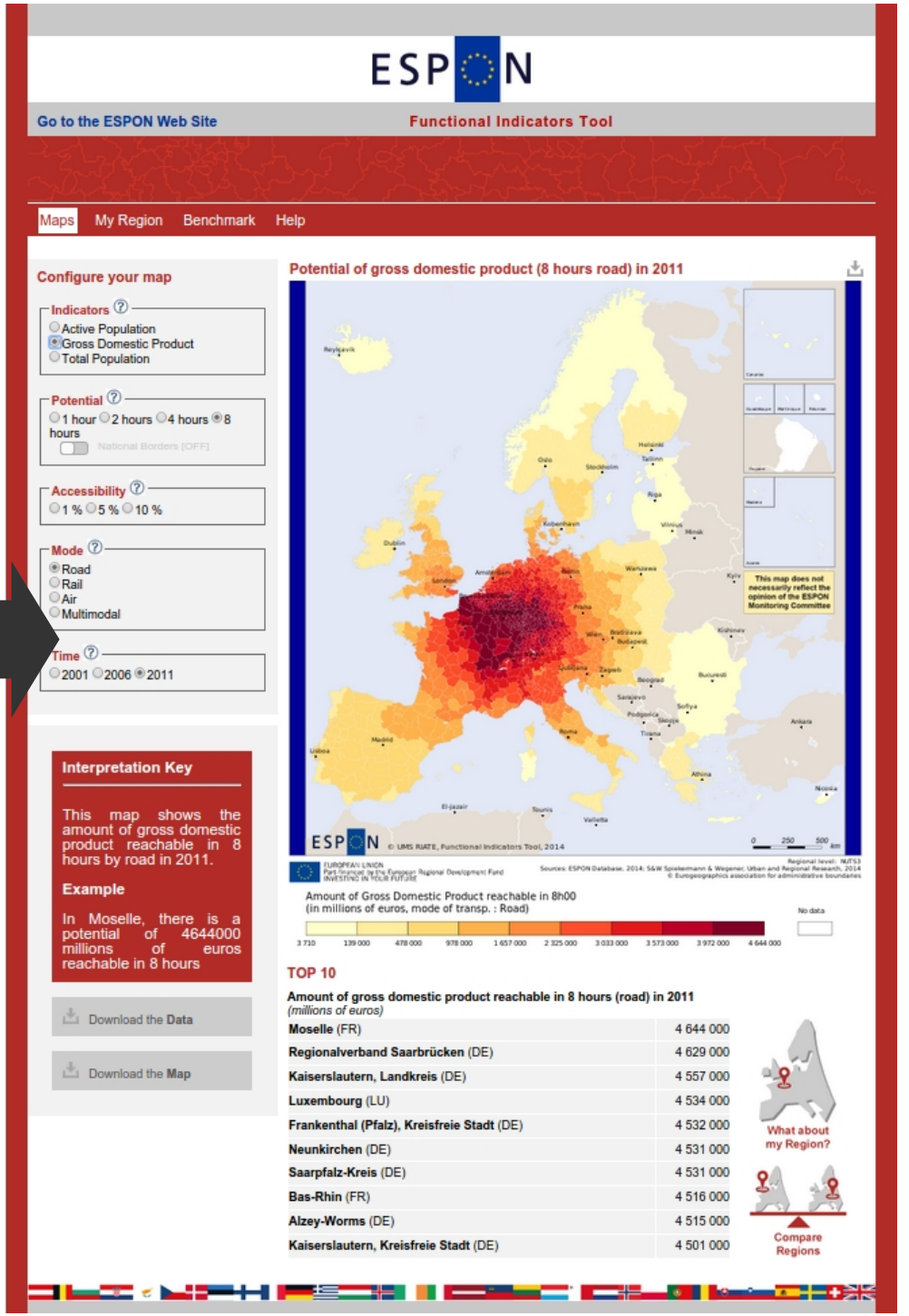
A free software environment for statistical computing and graphics.

Extended by a lot of of community-developed external libraries (packages)

- *SpatialPosition* package created to compute gravitational potential (Stewart potentials)

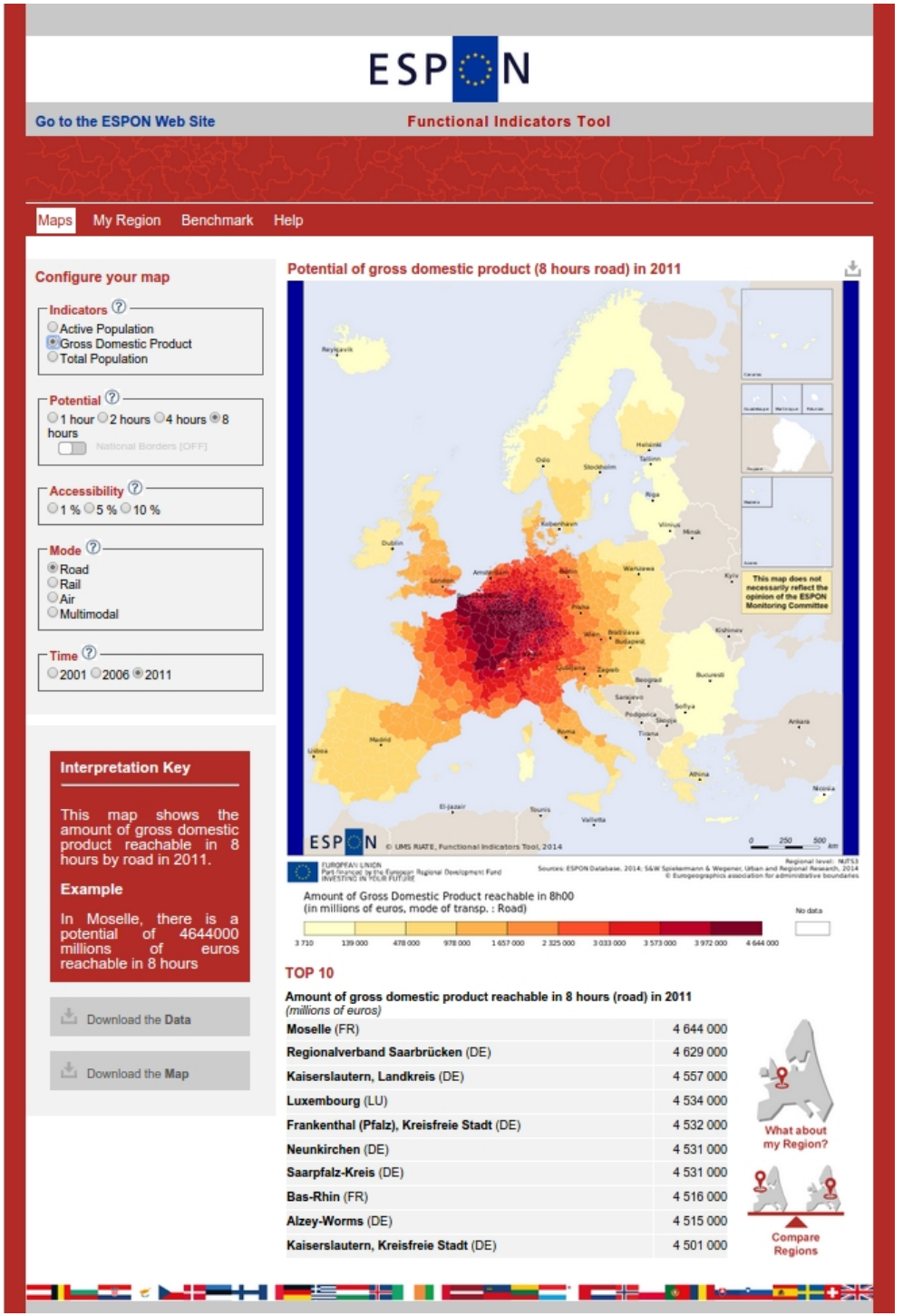
- Various mapping packages

A European Tool (FIT)



http://fit.espon.eu/

A European Tool (FIT)



A European Tool (FIT)

User Case

Choosing an optimal location: the EU parliament visitor's centers

- Close to a minimum number of 6 000 000 inhabitants
- In a capital region far from London, Brussels and Paris
- Reachable within 2 hours by road

A European Tool (FIT)

User Case

Configure your map

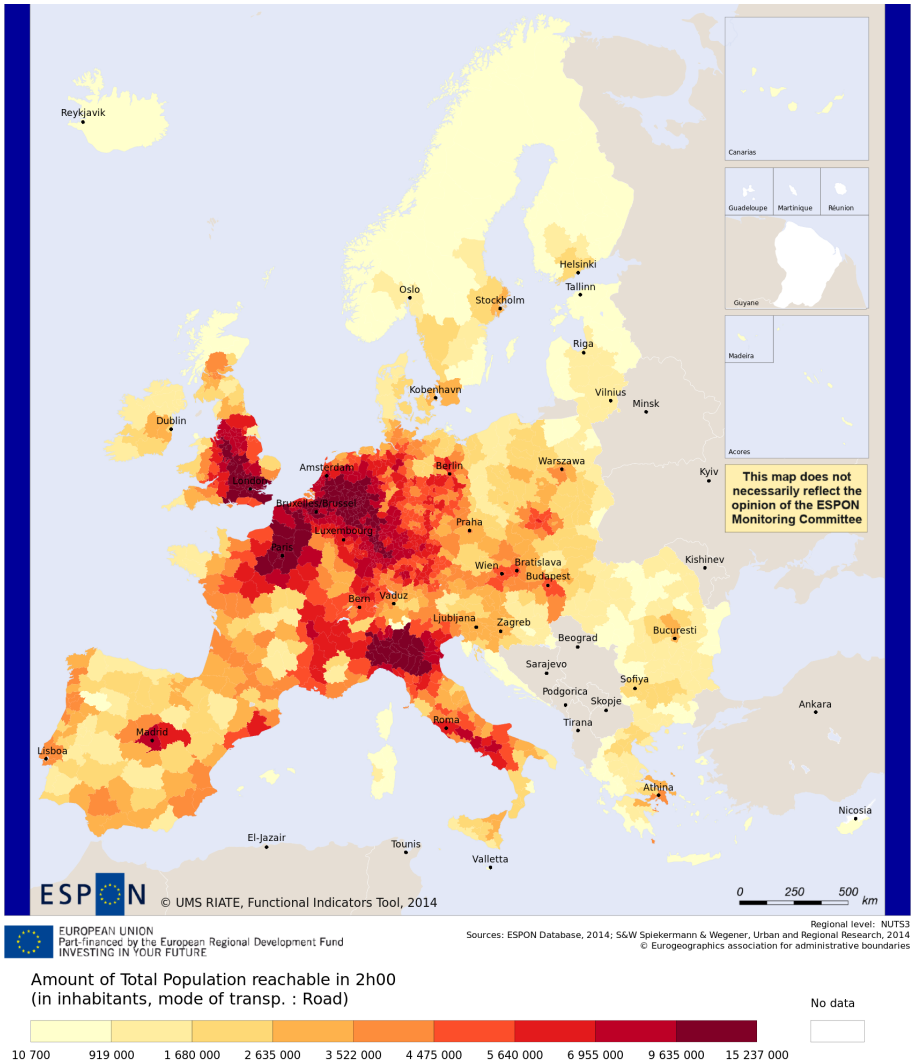
Indicators
- ○ Active Population
- ○ Gross Domestic Product
- ◉ Total Population

Potential
○ 1 hour ◉ 2 hours ○ 4 hours ○ 8 hours
National Borders [OFF]

Accessibility
○ 1 % ○ 5 % ○ 10 %

Mode
- ◉ Road
- ○ Rail
- ○ Air
- ○ Multimodal

Time
○ 2001 ○ 2006 ◉ 2011



Interpretation Key

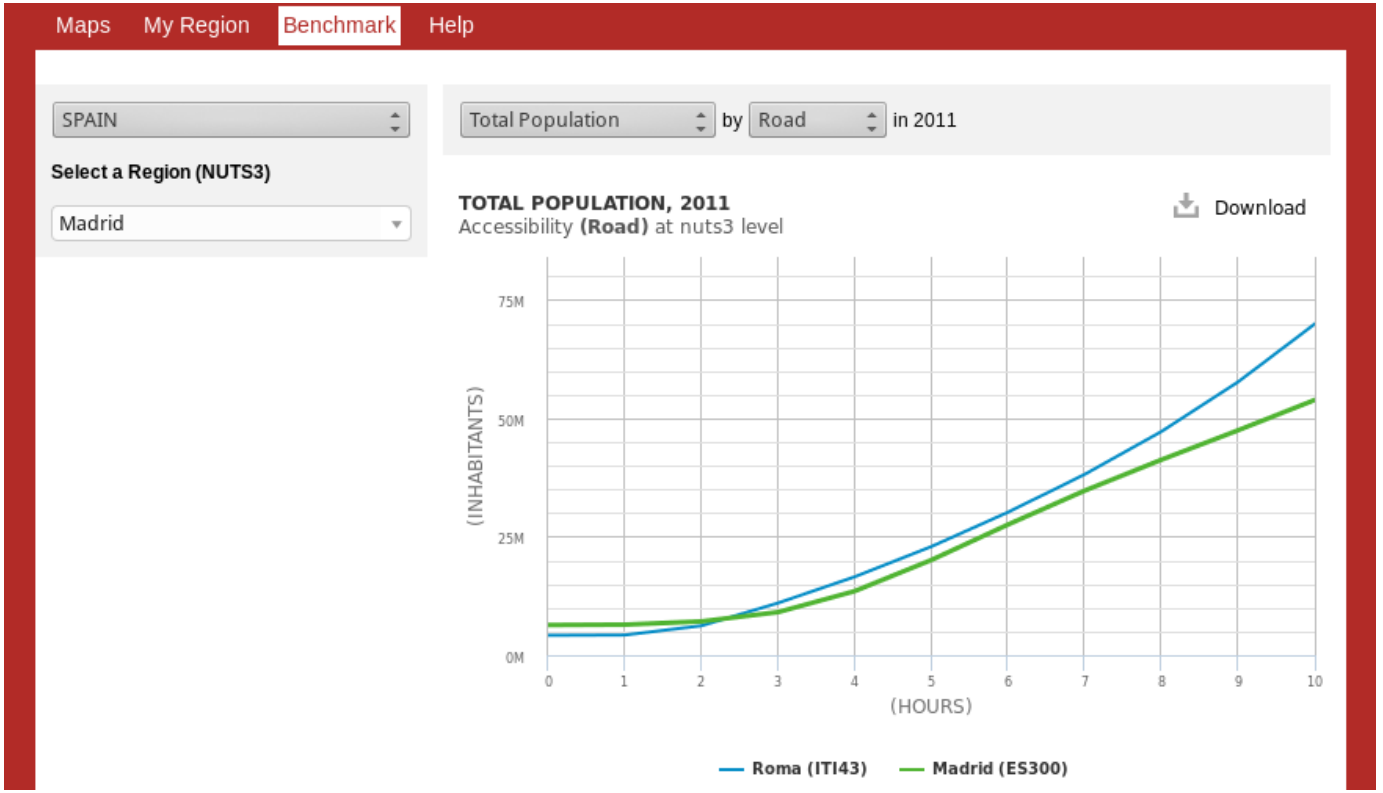
This map shows the amount of total population reachable in 2 hours by road in 2011.

Example

In Duisburg, Kreisfreie Stadt, there is a potential of 15237000 inhabitants reachable in 2 hours

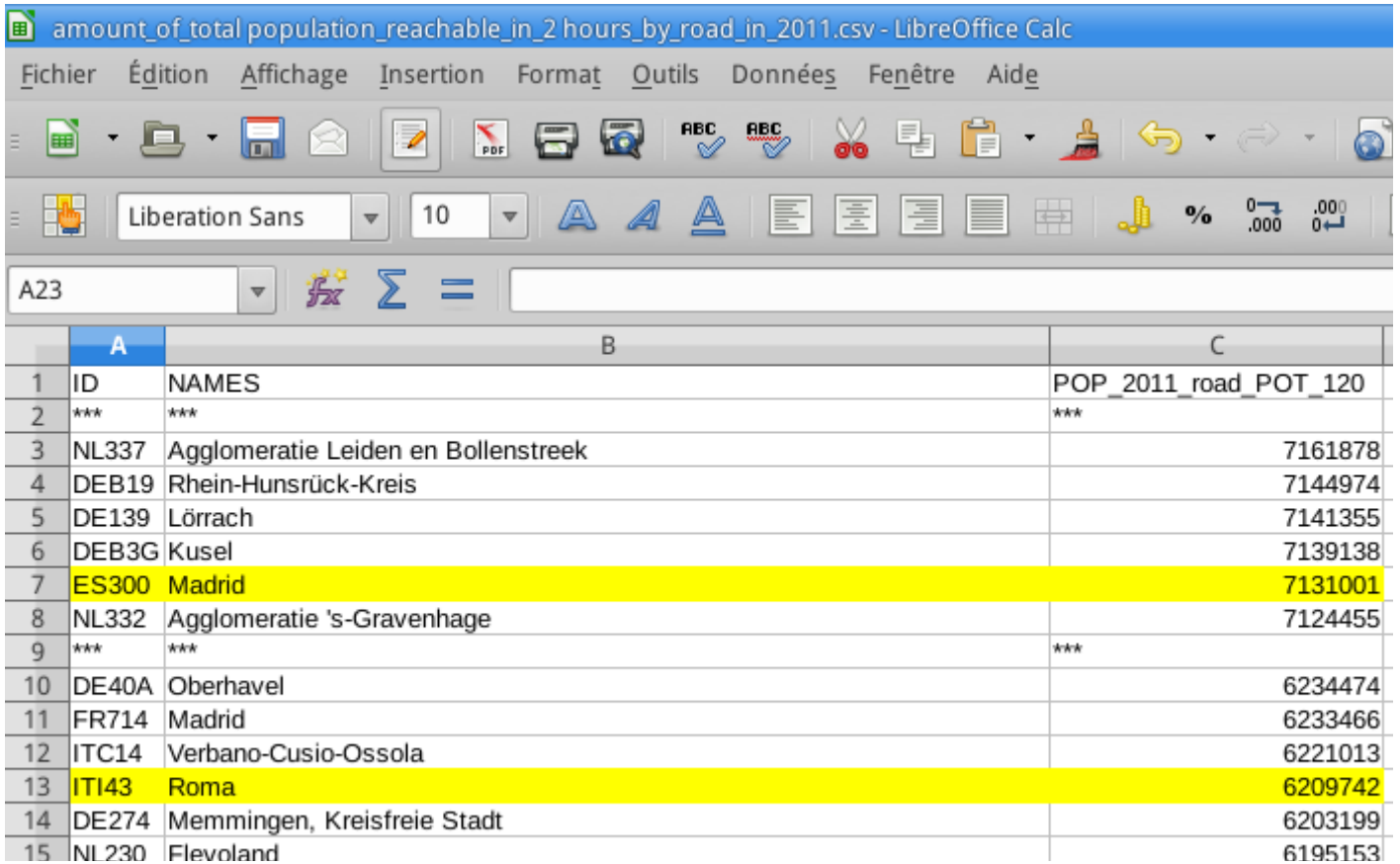
A European Tool (FIT)

User Case



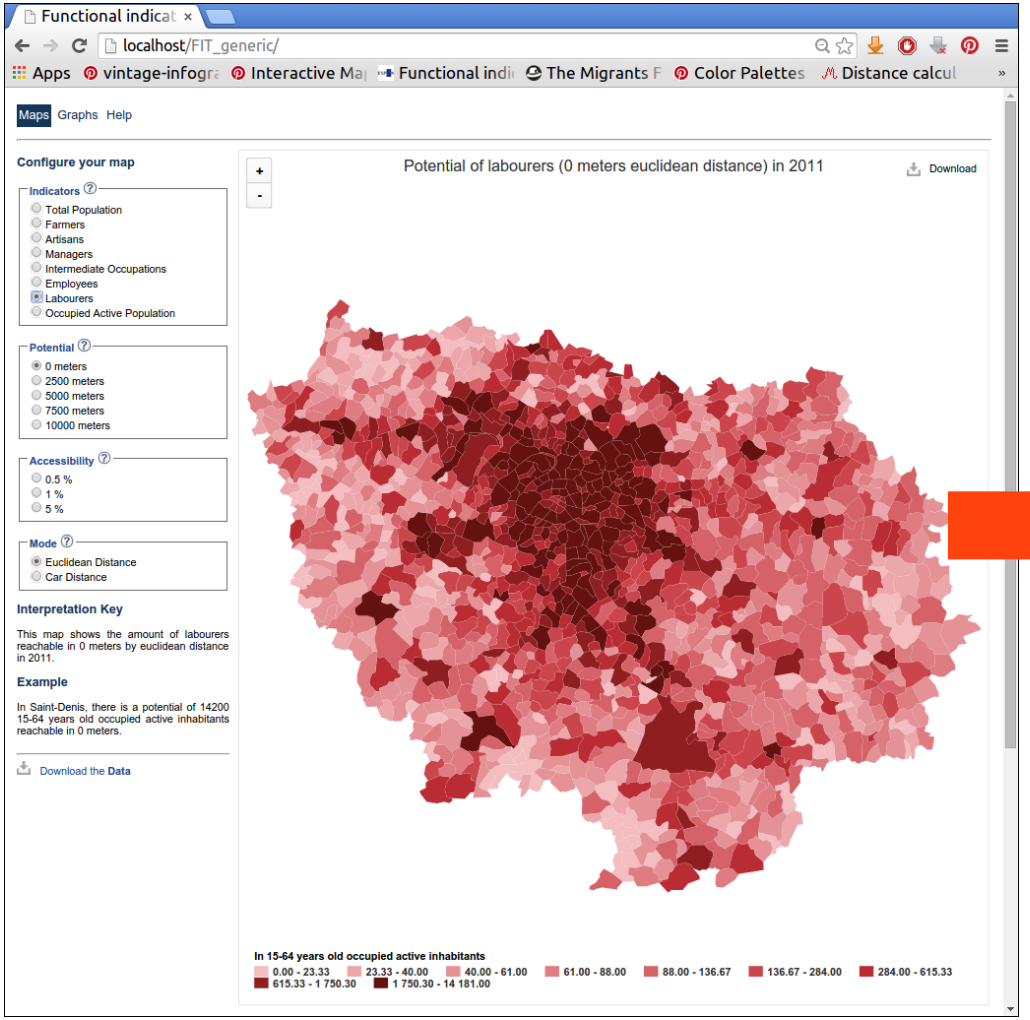
A European Tool (FIT)

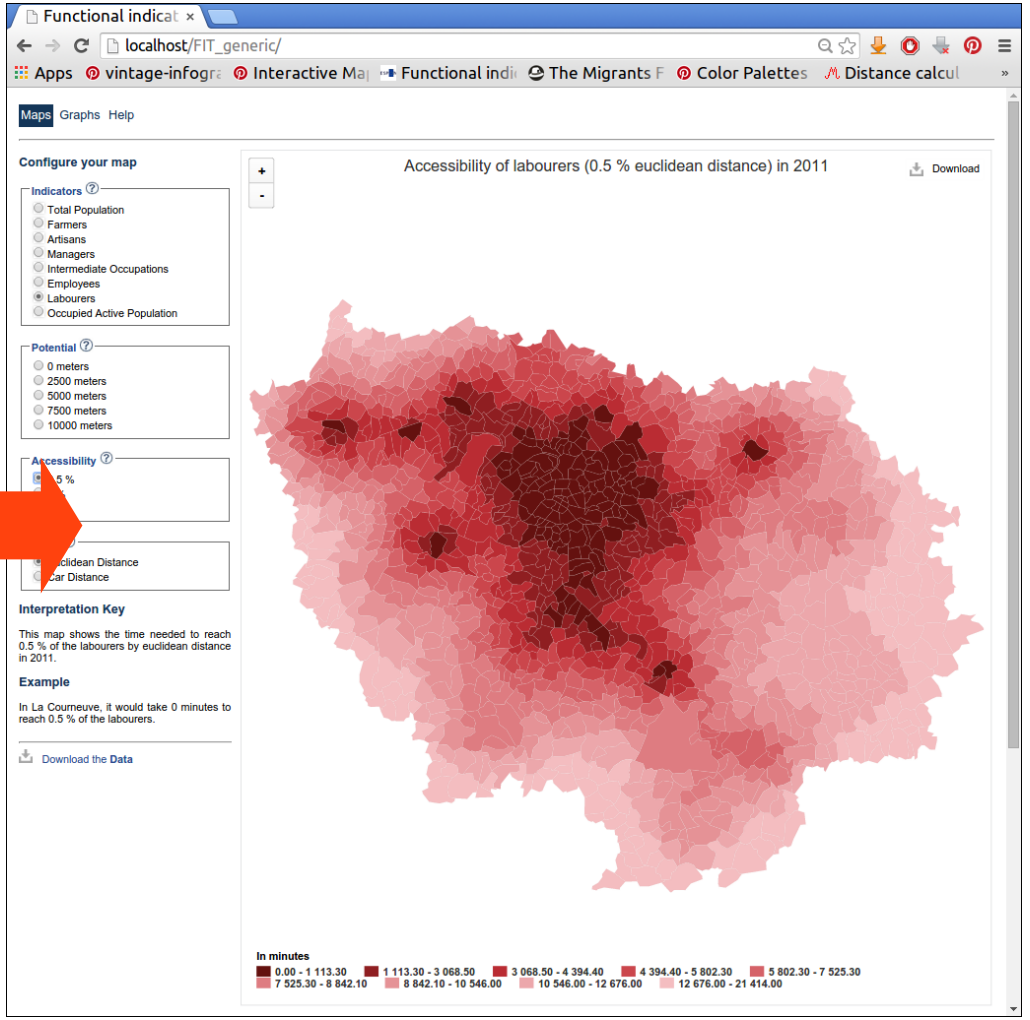
▶ User Case



	A	B	C
1	ID	NAMES	POP_2011_road_POT_120
2	***	***	***
3	NL337	Agglomeratie Leiden en Bollenstreek	7161878
4	DEB19	Rhein-Hunsrück-Kreis	7144974
5	DE139	Lörrach	7141355
6	DEB3G	Kusel	7139138
7	ES300	Madrid	7131001
8	NL332	Agglomeratie 's-Gravenhage	7124455
9	***	***	***
10	DE40A	Oberhavel	6234474
11	FR714	Madrid	6233466
12	ITC14	Verbano-Cusio-Ossola	6221013
13	ITI43	Roma	6209742
14	DE274	Memmingen, Kreisfreie Stadt	6203199
15	NL230	Flevoland	6195153

Do it yourself





https://github.com/Groupe-ElementR/(available soon)

Thank you

http://rgeomatic.hypotheses.org/
http://neocarto.hypotheses.org/

http://fit.espon.eu/
http://www.ums-riate.fr/funci/